PIONEER VENUS

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SCIENCE INSTRUMENT SURVEY

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National Aeronautics and Space Administration
Ames Research Center
Moffett Field, California

PIONEER VENUS

SCIENCE INSTRUMENT SURVEY

PREPARED FOR

AMES RESEARCH CENTER

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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FOREWORD

This document, the Science Instrument Survey, provides a synopsis of 130 scientific instruments, either flown or planned, for 19 NASA-connected space missions. This survey is intended for use as an aid in developing new scientific hardware or utilization of present hardware for future flights. The survey is arranged chronologically by the actual or scheduled spacecraft mission launch date. Within each spacecraft mission the instrument groups are presented alphabetically by experiment category.

Each instrument is presented in a brief standardized format which includes descriptive material, physical characteristics, operating parameters, and supportive illustrations where available. Data sources, which provided the basis for the information presented here, and reference sources, where further information may be obtained, are also included within each instrument format.

Additionally, a list of abbreviations and symbols may be found preceding the survey. For ease of reference, an alphabetical index is also provided in the back of the survey listing by experiment category and instrument name, the page on which the instrument data appears.

TABLE OF CONTENTS

ABBREVIATIONS AND SYMBOLS

angstrom	Å
ampere	amp
argon	Ar
astronomical unit	AU
billion electron volts	Bev
cubic centimeter	cc
centimeter	cm
cubic inch	cu in.
diameter	diam
effective field of view	EFOV
electron volts	eV
Fahrenheit	F
gamma	γ
gram	g
helium	He
helium ion	He+
hertz	Hz
hydrogen	H
instantaneous field of view	IFOV
Jupiter radii	R_j
Kelvin	K
kiloelectron volts	keV
kilogram	kg
kilohertz	kHz
kilometer	km
kilometers per second	km/sec
low energy telescope	LET
main telescope	MT
megahertz	MHz
meter	m
micron	μ
millimeter	mm
million electron volts	MeV
milliradian	mrad
minute (angular measure)	'
neon	Ne
radian	rad
radioisotope thermoelectric generator	RTG
radius	rad.
Scanning Electron Spectrometer	SES
Scanning Electrostatic Analyzer	SEA
second (angular measure)	"
section	Sec.
square inch	sq in.
steradian	ster
ultraviolet	uv
volt	V
watts	W

SCIENCE INSTRUMENT SURVEY

EXPERIMENT CATEGORY: Ionizing Radiation, High Energy Charged Particles

DATE OF LAUNCH: 16 December 1965

INSTRUMENT NAME: Cosmic Ray Anisotropy Detector

SPACECRAFT: Pioneer 6

DESTINATION: Heliocentric Orbit

PRINCIPAL INVESTIGATOR: K.G. McCracken, SCAS

INSTRUMENT CONTRACTOR: Southwest Center for Advanced Studies

PURPOSE: To measure the anisotropy of low energy primary and solar cosmic radiation and to measure its variation with energy, time and nuclear species.

DESCRIPTION: This instrument consists of a scintillator crystal, an anti-coincidence scintillator, two photomultiplier tubes, and associated electronics. The acceptance cone for the detector is 107°. Energy window discrimination is achieved by means of a four-channel on-board pulse-height analyzer. A time division circuit, the aspect clock, generates four time gates of precisely equal length. The first time period commences when the detector axis points 139° west of the Sun. Succeeding periods commence at precisely 90°, 180° and 270° of spacecraft rotation. Three primary modes of operation, "Dynamic Range Off," "Dynamic Range On," and "Calibrate" are selectable by ground command. In the "Dynamic Range Off" operating mode, the length of each time period is equivalent to nearly ¼ of a spacecraft revolution. In the "Dynamic Range On" operating mode, the length of each time period is equivalent to approximately 1/32 of a spacecraft revolution. These time gates route the pulses from any one channel of the pulse-height analyzer into one of four binary accumulators corresponding to each of the four time gates. Hence, concurrent measurements of cosmic ray fluxes are obtained from each of the three energy bands enumerated above.

PARAMETER SUMMARY:

Dimensions: 19.3 x 16.5 x 12.7 cm (7.6 x 6.5 x 5.0 in.)

Weight: 2.0 kg (4.4 lbs)

Power:	1.6 W
Ranges:	Energy Windows - 7.5 to 45, 45 to 90, 150 to 350 MeV/nucleon Electrons - 7.5 to 13 MeV
SOURCE:	
Data:	Pioneer Program Specifications Booklet: PC-121.00-08. TRW, Pioneer Handbook (1965-1969), December, 1968.
Reference:	Ames Research Center, Pioneer VI Mission, 22 May 1967.

EXPERIMENT CATEGORY:	Ionizing Radiation, High Energy Charged Particles
DATE OF LAUNCH:	16 December 1965
INSTRUMENT NAME:	Cosmic Ray Detector
SPACECRAFT:	Pioneer 6
DESTINATION:	Heliocentric Orbit
PRINCIPAL INVESTIGATOR:	J.A. Simpson, University of Chicago
INSTRUMENT CONTRACTOR:	University of Chicago

PURPOSE: To measure the intensity, energy spectrum, and angular distribution of protons, Alphas, and electrons.

DESCRIPTION: This instrument consists of three solid state lithium-drifted detectors, a plastic scintillator cylinder designed to exclude particles not confined to the telescope cone angle of 60°, a photomultiplier tube, and associated electronics. Aside from the input discriminator logic, typical of this type of instrument, the electronics basically consists of the necessary readout logic to interface with the spacecraft data - handling subsystem, four counter registers which provide the nondestructive readout of four separate counting rates, one 128-channel pulse-height analyzer, one 32-channel pulse-height analyzer, and a solar aspect counter. The latter, using spacecraft timing signals, generates timing signals within the instrument to indicate the direction of the instrument axis relative to the Sun so as to be able to determine the direction of the incoming particles. The first signal occurs and the cycle commences at the time that Sun Sensor E is illuminated by the Sun; the instrument axis points 115° of spacecraft rotation ahead of the Sun. The first internally generated signal occurs between 1/16 and 1/8 second later. Succeeding signals are 1/8 second apart until the spacecraft completes the revolution and the cycle starts again. This instrument can operate in one of two modes, normal and calibrate. In the calibrate mode, the coincidence/anti-coincidence logic circuitry is disabled to permit individual counting rates of the three solid state detectors to be read directly.

PARAMETER SUMMARY:

Dimensions:	19.0 x 14.5 x 20.3 cm (7.5 x 5.7 x 8.0 in.)
Weight:	2.1 kg (4.7 lbs)
Power:	1.2 W
Ranges:	Proton and Alphas - 0.6 to 13, 13 to 70, 70 to 190, and greater than 190 MeV/nucleon Electrons - 0.16 to 1 and 1 to 20 MeV

SOURCE:

Data:	Pioneer Program Specifications Booklet: PC-121.00-08. TRW, Pioneer Handbook (1965-1969), December, 1968.
Reference:	Ames Research Center, Pioneer VI Mission, 22 May 1967.

EXPERIMENT CATEGORY:	Magnetic Field
DATE OF LAUNCH:	16 December 1965
INSTRUMENT NAME:	Single Axis Magnetometer
SPACECRAFT:	Pioneer 6
DESTINATION:	Heliocentric Orbit
PRINCIPAL INVESTIGATOR:	N.F. Ness, GSFC
INSTRUMENT CONTRACTOR:	Goddard Space Flight Center

PURPOSE: To measure sequentially the magnitude of the three orthogonal components of the interplanetary magnetic field.

DESCRIPTION: This instrument has a single fluxgate sensor and associated electronics. The sensor is mounted on the end of one of the three spacecraft booms where the residual magnetic field of Pioneer VI was less than 0.5 y. It is aligned perpendicular to the boom axis and at an angle of 54° 45' to the plane containing the boom and spin axis. Thus, at any three positions separated by 120° of spacecraft rotation, the sensor direction at one position is orthogonal to that at the other two positions. The sensor consists of a saturable magnetic core which is excited at 13 kHz from positive to negative saturation by a solenoidal drive coil. The magnitude of the second harmonic 26 kHz signal measured by a tuned amplifier connected to a secondary coil winding is proportional to the component of the external magnetic field along the sensor axis and the permanent magnetization of the core itself. A mechanical flip mechanism which rotates the sensor through 180° permits detection and, thus, elimination of the latter effect. The flip mechanism contains 22 small squibs grouped in pairs for redundancy. Each squib of a pair when individually fired releases a spring with an escapement mechanism to reverse the direction of the sensor by precisely 180°. Each pair of squibs is activated by ground command.

PARAMETER SUMMARY:

Dimensions: 27.2 x 8.4 x 12.4 cm (10.7 x 3.3 x 4.9 in.); 203.2 cm (80.0 in.) from sensor to spacecraft axis of rotation

Weight:	2.6 kg (5.8 lbs)
Power:	0.8 W
Range:	± 64 Y
SOURCE:	
Data:	Pioneer Program Specifications Booklet: PC-121.00-08. TRW, Pioneer Handbook (1965-1969), December, 1968.
Reference:	Ames Research Center, Pioneer VI Mission, 22 May 1967.

EXPERIMENT CATEGORY: Plasma

DATE OF LAUNCH: 16 December 1965

INSTRUMENT NAME: Solar Plasma Detector

SPACECRAFT: Pioneer 6

DESTINATION: Heliocentric Orbit

PRINCIPAL INVESTIGATOR: J.H. Wolfe, ARC

INSTRUMENT CONTRACTOR: Ames Research Center

PURPOSE: To measure the energy spectrum, flux, and angular distribution of both positive ions and electrons of interplanetary plasma.

DESCRIPTION: This instrument has a quadrispherical electrostatic analyzer, eight separate and contiguous current collectors to provide the eight sectors, and associated electronics. The instantaneous viewing angle is approximately 15° in the plane perpendicular to the spacecraft spin axis (equatorial plane) and ± 80° in the plane parallel to the spin axis. The latter is divided into 8 channels which are symmetrical about the equatorial plane and have widths, commencing at the equatorial plane of 15°, 15°, 20° and 30°. The angular distribution about the spin axis is obtained by measuring the total particle flux in 15 consecutive intervals; the first 4 and last 3 correspond to 45° of spacecraft rotation and the remaining 8 correspond to 5-5/8° of spacecraft rotation. The first interval begins at 202½° of spacecraft rotation before the instrument axis points toward the Sun; thus, the eight small intervals are symmetric with respect to the time of instrument axis and Sun alignment.

PARAMETER SUMMARY:

Dimensions: 20.3 x 19.5 x 15.2 cm (8.0 x 7.7 x 6.0 in.)

Weight: 2.9 kg (6.3 lbs)

Power: 1.9 W

Range: Energy/Charge
Positive Ions - 0.2 to 10 kV (16 bands)
Electrons - 0.002 to 0.5 keV (8 bands)
Flux sensitivity - 10^5 to 10^9 particles/cm^2 - sec

SOURCE:

Data: Pioneer Program Specifications Booklet: PC-121.00-08.
TRW, Pioneer Handbook (1965-1969), December, 1968.

Reference: Ames Research Center, Pioneer VI Mission, 22 May 1967.

EXPERIMENT CATEGORY: Plasma

DATE OF LAUNCH: 16 December 1965

INSTRUMENT NAME: Solar Plasma Detector

SPACECRAFT: Pioneer 6

DESTINATION: Heliocentric Orbit

PRINCIPAL INVESTIGATOR: H.S. Bridge, M.I.T.

INSTRUMENT CONTRACTOR: Massachusetts Institute of Technology

PURPOSE: To measure the energy spectrum, flux, and angular distribution of both positive ions and electrons of the interplanetary plasma.

DESCRIPTION: This instrument consists of a detector that utilizes a Faraday cup with an energy-determining grid, a split collector, and associated electronics. A voltage applied to the grid alternates at approximately 1800 Hz between two voltage levels, thus producing a pulsating current at the collector by passing and then repelling incoming particles whose energy to charge ratio is within the applied voltage band. The electronics system is coupled to the collector and responds only to the pulsating component of the current. The current from half of the split collector and the total collector current are measured; the ratio of these currents gives an approximate indication of the direction of flow in the plane of the spin axis. Measurements to be telemetered are stored as 6-bit words in a 256-word memory. The viewing angle is ± 20° in the plane perpendicular to the spacecraft spin axis and ± 60° in the plane parallel to the spin axis. The instrument can be placed in one of two operating modes by ground command. In the primary mode, the instrument cycles through all the voltage intervals available. In the other mode, the four highest voltage intervals are excluded.

PARAMETER SUMMARY:

Dimensions: 17.3 x 20.1 x 12.4 cm (6.8 x 7.9 x 4.9 in.)

Weight: 2.8 kg (6.1 lbs)

Power:	2.3 W
Ranges:	Energy/Charge Positive Ions - 0.1 to 9.5 kV (14 bands) Electrons - 0.1 to 1.6 keV (4 bands) Flux Sensitivity - 2 x 10^5 to 2 x 10^9 particles/cm^2 - sec

SOURCE:

Data:	Pioneer Program Specification Booklet: PC-121.00-08. TRW, Pioneer Handbook (1965-1969), December, 1968.
References:	Ames Research Center, Pioneer VI Mission, 22 May 1967.

EXPERIMENT CATEGORY: Radio Frequency Propagation

DATE OF LAUNCH: 16 December 1965

INSTRUMENT NAME: Radio Propagation

SPACECRAFT: Pioneer 6

DESTINATION: Heliocentric Orbit

PRINCIPAL INVESTIGATOR: V.R. Eshleman, Stanford University

INSTRUMENT CONTRACTOR: Stanford University

PURPOSE: To measure the relative phase-modulation relationships between the 49.8 and 423.3 MHz coherent carriers transmitted from the Stanford 150-foot dish antenna to the experiment receivers, permitting the determination of the value and time variation of the integrated electron density between the Earth and the spacecraft.

DESCRIPTION: This instrument consists of two ground-based transmitters operating into a 45-meter (150-foot) diameter parabolic antenna located on the Stanford campus, a dual channel, phase-locked-loop receiver aboard the spacecraft, the spacecraft telemetry, and the Deep Space Network. All of the elements of the system just described must operate simultaneously to provide a closed loop operation. The receivers are designed to measure the relative phase of the modulation envelopes of the two carrier frequencies which, since the higher frequency is relatively unaffected by the presence of ionization, provides a value for the integrated electron density. In addition, the rate of change of phase of one carrier with respect to the other is measured, thus accurately determining the time variation of the integrated electron density. Signal strength is also measured.

PARAMETER SUMMARY:

Dimensions: 17.0 x 15.2 x 17.0 cm (6.7 x 6.0 x 6.7 in.)

Weight: 2.7 kg (6.0 lbs)

Power: 1.6 W

SOURCE:

Data: Pioneer Program Specifications Booklet: PC-121.00-08.
TRW, Pioneer Handbook (1965-1969), December, 1968.

Reference: Ames Research Center, Pioneer VI Mission, 22 May 1967.

EXPERIMENT CATEGORY:	Ionizing Radiation, High Energy Charged Particles
DATE OF LAUNCH:	17 August 1966
INSTRUMENT NAME:	Cosmic Ray Anisotropy Detector
SPACECRAFT:	Pioneer 7
DESTINATION:	Heliocentric Orbit
PRINCIPAL INVESTIGATOR:	K.G. McCracken, SCAS
INSTRUMENT CONTRACTOR:	Southwest Center for Advanced Studies

PURPOSE: To measure the anisotropy of low energy primary and solar cosmic radiation and to measure its variation with energy, time, and nuclear species.

DESCRIPTION: This instrument consists of a scintillator crystal, an anti-coincidence scintillator, two photomultiplier tubes, and associated electronics. The acceptance cone for the detector is 107°. Energy window discrimination is achieved by means of a four-channel on-board pulse-height analyzer. A time division circuit, the aspect clock, generates four time gates of precisely equal length. The first time period commences when the detector axis points 139° west of the Sun. Succeeding periods commence at precisely equal length. The first time period commences when the detector axis points 139° west of the Sun. Succeeding periods commence at precisely 90°, 180°, and 270° of spacecraft rotation. Three primary modes of operation, "Dynamic Range Off", "Dynamic Range On", and "Calibrate" are selectable by ground command. In the "Dynamic Range Off" operating mode, the length of each time period is equivalent to nearly 1/4 of a spacecraft revolution. In the "Dynamic Range On" operating mode, the length of each time period is equivalent to approximately 1/32 of a spacecraft revolution. These time gates route the pulses from any one channel of the pulse-height analyzer into one of four binary accumulators corresponding to each of the four time gates. Hence, concurrent measurements of cosmic ray fluxes are obtained from each of the three energy bands enumerated above.

PARAMETER SUMMARY:

Dimensions:	19.3 x 16.5 x 12.7 cm (7.6 x 6.5 x 5.0 in.)
Weight:	2.0 kg (4.4 lbs)
Power:	1.6 W
Ranges:	Energy Windows - 7.5 to 45, 45 to 90, 150 to 350 MeV/nucleon Electrons - 7.5 to 13 MeV

SOURCE:

Data:	JPL, Technical Memorandum No. 33-426 Vol. II, 15 April 1970. TRW, Pioneer Handbook (1965-1969), December, 1968.
Reference:	

EXPERIMENT CATEGORY:	Ionizing Radiation, High Energy Charged Particles
DATE OF LAUNCH:	17 August 1966
INSTRUMENT NAME:	Cosmic Ray Detector
SPACECRAFT:	Pioneer 7
DESTINATION:	Heliocentric Orbit
PRINCIPAL INVESTIGATOR:	J.A. Simpson, University of Chicago
INSTRUMENT CONTRACTOR:	University of Chicago

PURPOSE: To measure the intensity, energy spectrum and angular distribution of protons, Alphas and electrons.

DESCRIPTION: This instrument consists of three solid state lithium-drifted detectors, a plastic scintillator cylinder designed to exclude particles not confined to the telescope cone angle of 60°, a photomultiplier tube, and associated electronics. Aside from the input discriminator logic, typical of this type of instrument, the electronics basically consists of the necessary readout logic to interface with the spacecraft data-handling subsystem, four counter registers which provide the non-destructive readout of four separate counting rates, one 128-channel pulse-height analyzer, one 32-channel pulse-height analyzer, and a solar aspect counter. The latter, using spacecraft timing signals, generates timing signals within the instrument to indicate the direction of the instrument axis relative to the Sun so as to be able to determine the direction of the incoming particles. The first signal occurs and the cycle commences at the time that Sun Sensor E is illuminated by the Sun; the instrument axis points 115° of spacecraft rotation ahead of the Sun. The first internally generated signal occurs between 1/16 and 1/8 second later. Succeeding signals are 1/8 second apart until the spacecraft completes the revolution and the cycle starts again. The instrument can operate in one of two modes, normal and calibrate. In the calibrate mode, the coincidence/anti-coincidence logic circuitry is disabled to permit individual counting rates of the three solid state detectors to be read directly.

PARAMETER SUMMARY:

Dimensions:	19.0 x 14.5 x 20.3 cm (7.5 x 5.7 x 8.0 in.)
Weight:	2.1 kg (4.7 lbs)
Power:	1.2 W
Ranges:	Proton and Alphas - 0.6 to 13, 13 to 70, 70 to 190, and greater than 190 MeV/Nucleon Electrons - 0.16 to 1 and 1 to 20 MeV

SOURCE:

Data:	JPL, Technical Memorandum No. 33-426 Vol. II, 15 April 1970. TRW, Pioneer Handbook (1965-1969), December, 1968.

Reference:

EXPERIMENT CATEGORY:	Magnetic Field
DATE OF LAUNCH:	17 August 1966
INSTRUMENT NAME:	Single Axis Magnetometer
SPACECRAFT:	Pioneer 7
DESTINATION:	Heliocentric Orbit
PRINCIPAL INVESTIGATOR:	N.F. Ness, GSFC
INSTRUMENT CONTRACTOR:	Goddard Space Flight Center

PURPOSE: To measure sequentailly the magnitude of the three orthogonal components of the interplanetary magnetic field.

DESCRIPTION: This instrument has a single fluxgate sensor and associated electronics. The sensor is mounted on the end of one of the three spacecraft booms where the residual magnetic field of Pioneer VI was less than 0.5 γ. It is aligned perpendicular to the boom axis and at an angle of 54°, 45' to the plane containing the boom and spin axis. Thus, at any three positions separated by 120° of spacecraft rotation, the sensor direction at one position is orthogonal to that at the other two positions. The sensor consists of a saturable magnetic core which is excited at 13 kHz from positive to negative saturation by a solenoidal drive coil. The magnitude of the second harmonic 26 kHz signal measured by a tuned amplifier connected to a secondary coil winding is proportional to the component of the external magnetic field along the sensor axis and the permanent magnetization of the core itself. A mechanical flip mechanism which rotates the sensor through 180° permits detection and, thus, elimination of the latter effect. The flip mechanism contains 22 small squibs grouped in pairs for redundancy. Each squib of a pair when individually fired releases a spring with an escapement mechanism to reverse the direction of the sensor by precisely 180°. Each pair of squibs is activated by a ground command.

PARAMETER SUMMARY:

Dimensions: 27.2 x 8.4 x 12.4 cm (10.7 x 3.3 x 4.9 in.); 203.2 cm (80 in.) from sensor to spacecraft axis of rotation.

Weight:	2.6 kg (5.8 lbs)
Power:	0.8 W
Range:	± 64 γ
SOURCE:	
Data:	JPL, Technical Memorandum No. 33-426 Vol. II, 15 April, 1970. TRW, Pioneer Handbook (1965-1969), December, 1968.
Reference:	

EXPERIMENT CATEGORY:	Plasma
DATE OF LAUNCH:	17 August 1966
INSTRUMENT NAME:	Solar Plasma Detector
SPACECRAFT:	Pioneer 7
DESTINATION:	Heliocentric Orbit
PRINCIPAL INVESTIGATOR:	J.H. Wolfe, ARC
INSTRUMENT CONTRACTOR:	Ames Research Center

PURPOSE: To measure the energy spectrum, flux, and angular distribution of both positive ions and electrons of the interplanetary plasma.

DESCRIPTION: This instrument has a quadrispherical electrostatic analyzer, eight separate and contiguous current collectors to provide the eight sectors, and associated electronics. The instantaneous viewing angle is approximately 15° in the plane perpendicular to the spacecraft spin axis (equatorial plane) and ± 80° in the plane parallel to the spin axis. The latter is divided into 8 channels which are symmetrical about the equatorial plane and have widths, commencing at the equatorial plane of 15°, 15°, 20°, and 30°. The angular distribution about the spin axis is obtained by measuring the total particle flux in 15 consecutive intervals; the first 4 and last 3 correspond to 45° of spacecraft rotation and the remaining 8 correspond to 5-5/8° of spacecraft rotation. The first interval begins at 202½° of spacecraft rotation before the instrument axis points toward the Sun; thus, the eight small intervals are symmetric with respect to the time of instrument axis and Sun alignment.

PARAMETER SUMMARY:

Dimensions:	20.3 x 19.5 x 15.2 cm (8.0 x 7.7 x 6.0 in.)
Weight:	2.9 kg (6.3 lbs)
Power:	1.9 W

Range:	Energy/Charge Positive Ions - 0.2 to 10 kV (16 bands) Electrons - 0.002 to 0.5 keV (8 bands) Flux sensitivity - 10^5 to 10^9 particles/cm^2 - sec

SOURCE:

Data:	JPL, Technical Memorandum No. 33-426 Vol. II, 15 April 1970. TRW, Pioneer Handbook (1965-1969), December, 1968.

Reference:

EXPERIMENT CATEGORY: Plasma

DATE OF LAUNCH: 17 August 1966

INSTRUMENT NAME: Solar Plasma Detector

SPACECRAFT: Pioneer 7

DESTINATION: Heliocentric Orbit

PRINCIPAL INVESTIGATOR: H.S. Bridge, M.I.T.

INSTRUMENT CONTRACTOR: Massachusetts Institute of Technology

PURPOSE: To measure the energy spectrum, flux, and angular distribution of both positive ions and electrons of the interplanetary plasma.

DESCRIPTION: This instrument consists of a detector that utilizes a Faraday cup with an energy-determining grid, a split collector, and associated electronics. A voltage applied to the grid alternates at approximately 1800 Hz between two voltage levels, thus producing a pulsating current at the collector by passing and then repelling incoming particles whose energy to charge ratio is within the applied voltage band. The electronics system is coupled to the collector and responds only to the pulsating component of the current. The current from half of the split collector and the total collector current are measured; the ratio of these currents gives an approximate indication of the direction of flow in the plane of the spin axis. Measurements to be telemetered are stored as 6-bit words in a 256-word memory. The viewing angle is ± 20° in the plane perpendicular to the spacecraft spin axis and ± 60° in the plane parallel to the spin axis. The instrument can be placed in one of two operating modes by ground command. In the primary mode, the instrument cycles through all the voltage intervals available. In the other mode, the four highest voltage intervals are excluded.

PARAMETER SUMMARY:

Dimensions: 17.3 x 20.1 x 12.4 cm (6.8 x 7.9 x 4.9 in.)

Weight: 2.8 kg (6.1 lbs)

Power: 2.3 W

Ranges:	Energy/Charge Positive Ions - 0.1 to 9.5 kV (14 bands) Electrons - 0.1 to 1.6 keV (4 bands) Flux sensitivity - 2×10^5 to 2×10^9 particles/cm^2 - sec
SOURCE:	
Data:	JPL, Technical Memorandum No. 33-426 Vol. II, 15 April, 1970. TRW, Pioneer Handbook (1965-1969), December, 1968.
Reference:	

EXPERIMENT CATEGORY:	Radio Frequency Propagation
DATE OF LAUNCH:	17 August 1966
INSTRUMENT NAME:	Radio Propagation
SPACECRAFT:	Pioneer 7
DESTINATION:	Heliocentric Orbit
PRINCIPAL INVESTIGATOR:	V.R. Eshleman, Stanford University
INSTRUMENT CONTRACTOR:	Stanford University

PURPOSE: To measure the relative phase-modulation relationships between the 49.8 and 423.3 MHz coherent carriers transmitted from the Stanford 45-meter (150-foot) dish antenna to the experiment receivers, permitting the determination of the value and time variation of the integrated electron density between the Earth and the spacecraft.

DESCRIPTION: This instrument consists of two ground-based transmitters operating into a 45-meter (150-foot) diameter parabolic antenna located on the Stanford campus, a dual channel, phase-locked-loop receiver aboard the spacecraft, the spacecraft telemetry, and the Deep Space Network. All of the elements of the system just described must operate simultaneously to provide a closed loop operation. The receivers are designed to measure the relative phase of the modulation envelopes of the two carrier frequencies which, since the higher frequency is relatively unaffected by the presence of ionization, provides a value for the integrated electron density. In addition, the rate of change of phase of one carrier with respect to the other is measured, thus accurately determining the time variation of the integrated electron density. Signal strength is also measured.

PARAMETER SUMMARY:

Dimensions:	17.0 x 15.2 x 17.0 cm (6.7 x 6.0 x 6.7 in.)
Weight:	2.7 kg (6.0 lbs)
Power:	1.6 W

Range:

SOURCE:

Data:	JPL, Technical Memorandum No. 33-426 Vol. II, 15 April, 1970. TRW, Pioneer Handbook (1965-1969), December, 1968.

Reference:

EXPERIMENT CATEGORY: Ionizing Radiation

DATE OF LAUNCH: 14 June 1967

INSTRUMENT NAME: Trapped Radiation Detector

SPACECRAFT: Mariner 5

DESTINATION: Planet Venus

PRINCIPAL INVESTIGATOR: J.A. Van Allen, University of Iowa

INSTRUMENT CONTRACTOR:

PURPOSE: To determine occurrence and measure intensity and energy spectra of energetic particles in interplanetary space and their angular distribution with respect to the probe-sun line. To search for a trapped radiation belt around Venus and for charged particle effects in the magneto-hydrodynamic wake of Venus.

DESCRIPTION: A four-channel, solid-state detector using three type EON 6213 GM end window counters and one P-N surface barrier solid-state detector with the following unique thresholds: electrons - greater than or equal to 40 keV, protons - greater than or equal to 500 keV, 70° and 135° to probe-sun line, electrons - greater than or equal to 80 keV, protons - greater than or equal to 900 keV, 70° to probe-sun line, and protons - 500 keV to 8 MeV and 900 keV to 3.5 MeV. The window of Detector A was covered by about 1.4 mg/cm^2 of mica. Detector D was a totally depleted silicon surface-barrier diode with a 0.2 mg/cm^2 air equivalent for alpha particles nickel foil for light shielding.

PARAMETER SUMMARY:

Dimensions:

Weight: 1.2 kg (2.7 lbs)

Power: 450 mW

Range:

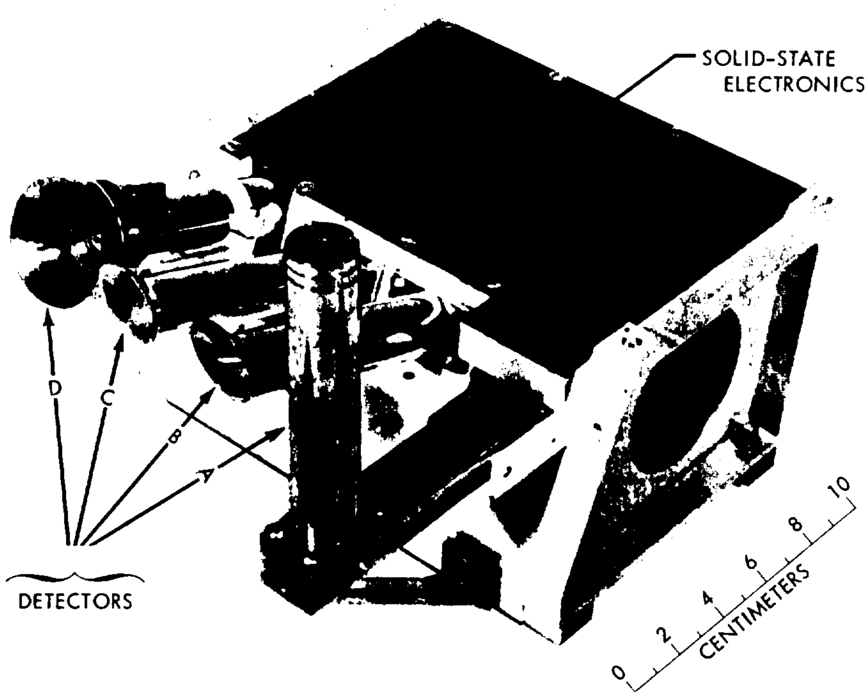
Chassis Volume: 1350 cm^3

Aperature Angle: 80° for Detector D

SOURCE:

Data: NASA, Mariner-Venus 1967 Final Project Report, NASA SP-190.
NSSDC AIM Printout (2 October 1972), ID No. 67-060A-04.

Reference:



Mariner 5 Trapped Radiation Detector

EXPERIMENT CATEGORY: Magnetic Field

DATE OF LAUNCH: 14 June 1967

INSTRUMENT NAME: Helium Magnetometer

SPACECRAFT: Mariner 5

DESTINATION: Planet Venus

PRINCIPAL INVESTIGATOR: E.J. Smith, NASA/JPL

INSTRUMENT CONTRACTOR:

PURPOSE: To determine the Venusian magnetic field strength and direction in order to reinvestigate the possible existence of an intrinsic magnetic moment of Venus; investigate the flow of solar wind around Venus; and study characteristics of the interplanetary magnetic field during a period of increasing solar activity.

DESCRIPTION: This instrument is a low-field vector helium magnetometer. It was located on the low gain antenna mast to minimize the effect of the spacecraft's magnetic fields. Electronics supporting the experiment are located in a compartment on the spacecraft. A sensor heater was a part of this instrument as was a thermal "diaper" on the ball. Five triaxial field samples are obtained every 50.4 seconds. The instrument has an intrinsic noise level of 0.1 gamma. The magnetometer is a closed loop device in which currents null out the ambient magnetic field within a set of small triaxial Helmholz coils (10 cm in diameter). The null field condition is identified by monitoring the Zeeman absorption of a resonance emission as it passes through a helium-filled cell placed at the center of the coils.

PARAMETER SUMMARY:

Dimensions:

Weight: 3.3 kg (7.2 lbs)

Power: 7 W

Dynamic Range: ± 20.48 gamma per axis

Sensitivity: 0.4 gamma per axis

Sweep Vector: 300 gamma

SOURCE:

Data: NASA, Mariner-Venus 1967 Final Project Report, NASA SP-190. NSSDC AIM Printout (2 October 1972), ID No. 67-060A-05.

Reference:

Mariner 5 Helium Magnetometer

EXPERIMENT CATEGORY: Plasma

DATE OF LAUNCH: 14 June 1967

INSTRUMENT NAME: Solar Plasma Detector

SPACECRAFT: Mariner 5

DESTINATION: Planet Venus

PRINCIPAL INVESTIGATOR: H.S. Bridge, M.I.T.

INSTRUMENT CONTRACTOR:

PURPOSE: To measure the flux, energy, and direction of arrival of solar plasma protons.

DESCRIPTION: This instrument consists of a modulated grid Faraday cup detector unit with an aperture through which the solar wind entered and a segmented collator plate. Plasma sensor look direction is directly along the sunline. The unit is mounted outside the spacecraft and a set of electronics is located in three modules within the spacecraft. All grids, with the exception of the modulation grid, are used to establish desired dc field conditions within the sensor. The instrument measures particle concentration in 32 overlapping velocity ranges (or energy windows). Instrument has a series string of 15 resistors. Two different sequencing modes are used: one for the cruise portion of the flight and the other only during encounter. The sensor accepts particles entering at angles as large as 60° from the sensor symmetry axis (the Sun-spacecraft line). A current measurement at one energy level has an integration time of approximately 5 msec and the sampling rate is such that a plasma energy spectrum is determined every 5 minutes.

PARAMETER SUMMARY:

Dimensions:

Weight: 2.9 kg (6.4 lbs)

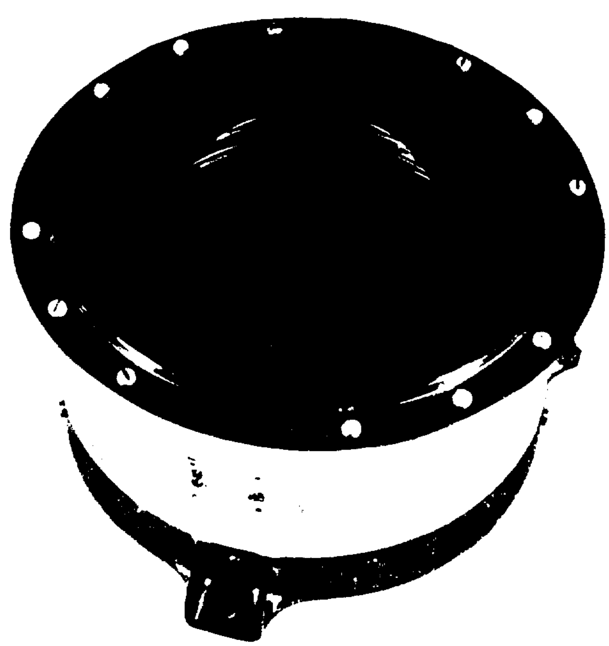
Power: 3 W

Range: 50-8700 V

SOURCE:

Data: NASA, Mariner-Venus 1967 Final Project Report, NASA SP-190.
NSSDC AIM Printout (2 October 1972), ID No. 67-060A-03.

Reference:



Mariner 5 Solar Plasma Detector

EXPERIMENT CATEGORY: Radio Frequency Ground Based Interferometry

DATE OF LAUNCH: 14 June 1967

INSTRUMENT NAME: Dual Frequency Receiving Antennas

SPACECRAFT: Mariner 5

DESTINATION: Planet Venus

PRINCIPAL INVESTIGATOR: V.R. Eshleman, Stanford University

INSTRUMENT CONTRACTOR:

PURPOSE: To provide data describing the interplanetary electron content of the solar wind and its variations.

DESCRIPTION: Signals of 423.3 MHz and 2/17 subharmonic 49.8 MHz are transmitted from the 45-meter (150-ft) diameter antenna at Stanford University to the dual frequency receiver on the spacecraft. The high-frequency signal served as a reference signal since its propagation time was not appreciably delayed. The low-frequency signal was delayed in proportion to the total electron content in the propagation path. On the spacecraft, a phase locked receiver counted the beat frequency zero crossings of the received signals to obtain measurements of phase-path differences. The spacecraft antenna was a quarter-wave stub with two reflector elements. An immediate-frequency amplifier had a crystal filter with a -3-dB bandwidth of 45 kHz and a -60-dB bandwidth of 500 kHz. The filter determined the bandwidth of the intermediate-frequency amplifier and was phase matched with an identical filter in the 49.8 MHz receiver to prevent introducing spurious phase shifts. A second mixer converted the signal to the second intermediate frequency of 7 MHz. This 7 MHz frequency was amplified, limited, and applied to the loop phase detectors.

PARAMETER SUMMARY:

Dimensions:

Weight:

Power:

Range: 423 MHz, 49.8 MHz

Calibration:	Every 512 frames

SOURCE:

Data:	NASA, Mariner-Venus 1967 Final Project Report, NASA SP-190. NSSDC AIM Printout (2 October 1972), ID No. 67-060A-02.

Reference:

EXPERIMENT CATEGORY:	Ultraviolet Photometry
DATE OF LAUNCH:	14 June 1967
INSTRUMENT NAME:	Ultraviolet Photometer
SPACECRAFT:	Mariner 5
DESTINATION:	Planet Venus
PRINCIPAL INVESTIGATOR:	C.A. Barth, University of Colorado
INSTRUMENT CONTRACTOR:	

PURPOSE: To measure the upper atmosphere of Venus; that is, to measure the density and distribution of atomic hydrogen and atomic oxygen and the temperature of the outer atmosphere of Venus.

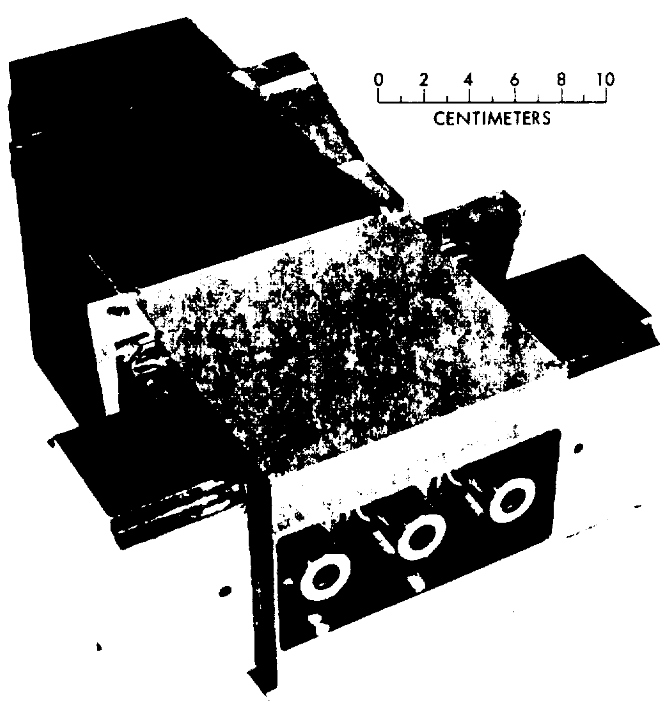
DESCRIPTION: The instrument consists of three photomultiplier tubes, each with a different filter to isolate different regions of the vacuum ultraviolet spectrum. The photomultipliers have cesium iodide photocathodes and lithium fluoride windows. The three filters are the lithium fluoride window of the first tube and additional filters of calcium fluoride and barium fluoride for the other two tubes. The effective passbands for the three channels are: 1050-2200 Å, 1250-2200 Å, and 1350-2200 Å. The difference between the signals observed by the first two channels is due to the 1216 Å-Lyman alpha line of atomic hydrogen, and the difference between the second and third channels is due to the 1304 Å triplet of atomic oxygen. The third channel also measures any ultraviolet radiation at wavelengths greater than 1350 Å. The three channels of the photometer are aligned and look in the same direction. The photomultiplier tubes operate with a variable high voltage controlled by the anode output current, so that each tube may operate with a dynamic range of 10^3 may be protected from potential damage due to the brightness of the planet's sunlit disk. A collimating aperture, in front of each phototubes and filter, was used to restrict the field of view.

PARAMETER SUMMARY:

Dimensions:	
Weight:	
Power:	
Range:	1050-2200 Å
Field of View:	3° for lithium fluoride-Lyman alpha channel 1.2° for other two channels.
Dynamic Range:	10^3

SOURCE:

Data:	Science, Vol. 158 (29 December 1967), pp. 1675-6.
Reference:	



Mariner 5 Ultraviolet Photometer

EXPERIMENT CATEGORY:	Electric Field
DATE OF LAUNCH:	13 December 1967
INSTRUMENT NAME:	Electric Field Detector
SPACECRAFT:	Pioneer 8
DESTINATION:	Heliocentric Orbit
PRINCIPAL INVESTIGATOR:	F.L. Scarf, TRW
INSTRUMENT CONTRACTOR:	TRW Systems

PURPOSE: To measure and identify short wavelength interplanetary proton and electron density irregularities which may cause scintillation, anomalous phase shifts and propagation delays of radio frequency signals.

DESCRIPTION: This instrument responds only to the electric field component of signals which arrive at the spacecraft parallel to the axis of the 423.3 MHz Stanford Radio Propagation antenna. The antenna is used as an unbalanced dipole feeding a broad bandwidth channel for noise survey; and a pair of narrow bandwidth channels centered on the nominal proton and electron frequencies for detection of plasma oscillations. The electric field components are filtered to allow detection in the range of 0.1 to 100 kHz while the 400 Hz and 22,000 Hz components are selected for amplitude measurement. The frequency and amplitude measurements are telemetered to Earth by the spacecraft.

PARAMETER SUMMARY:

Dimensions:	6.3 x 10.2 x 5.8 cm (2.5 x 4.0 x 2.3 in.)
Weight:	0.4 kg (0.9 lbs)
Power:	0.5 W
Range:	0.1 to 100 kHz

SOURCE:

Data: Pioneer Program Specifications Booklets: PC-122.00-08 and PC-146.04.
TRW, Pioneer Handbook (1965-1969), December, 1968.

Reference:

EXPERIMENT CATEGORY:	Ionizing Radiation, High Energy Charged Particles
DATE OF LAUNCH:	13 December 1967
INSTRUMENT NAME:	Cosmic Ray Anisotrophy Detector
SPACECRAFT:	Pioneer 8
DESTINATION:	Heliocentric Orbit
PRINCIPAL INVESTIGATOR:	K.G. McCracken, SCAS
INSTRUMENT CONTRACTOR:	Southwest Center for Advanced Studies

PURPOSE: To measure the quantity, intensity, energy, and gradient of protons, alpha particles, and heavier nuclei, in interplanetary space.

DESCRIPTION: This instrument is a multiple telescope detector system. It examines the anisotropic characteristics of the low energy portion of the solar and galactic cosmic radiation spectrum and analyzes its variations as to time, energy and nuclear species. The instrument consists of a scintillator crystal, an anti-coincidence scintillator, two photomultiplier tubes, and associated electronics. The instrument has two detector assemblies mounted side-by-side at the front of the instrument housing and protruding through the spacecraft viewing band approximately 77 cm^2 (12 sq in.). The energy range for protons is from 5 to 90 MeV, and for alpha particles from 150 to 360 MeV. The detector view angle is a 107° cone and the instrument requires a window of approximately 40.0 cm^2 (6.2 sq in.).

PARAMETER SUMMARY:

Dimensions:	17.5 x 19.0 x 13.7 cm (6.9 x 7.5 x 5.4 in.)
Weight:	2.5 kg (5.6 lbs)
Power:	1.8 W
Range:	Protons - 5 to 90 MeV Alpha Particles - 150 to 360 MeV

Detectors: Solid state ionization chambers, one cesium iodide crystal

SOURCE:

Data: Pioneer Program Specifications Booklets: PC-122.00-08 and PC-146.04.
TRW, Pioneer Handbook (1965-1969), December, 1968.

Reference:

EXPERIMENT CATEGORY:	Ionizing Radiation, High Energy Charged Particles
DATE OF LAUNCH:	13 December 1967
INSTRUMENT NAME:	Cosmic Ray Gradient Detector
SPACECRAFT:	Pioneer 8
DESTINATION:	Heliocentric Orbit
PRINCIPAL INVESTIGATOR:	W.R. Webber, University of Minnesota
INSTRUMENT CONTRACTOR:	University of Minnesota

PURPOSE: To measure the quantity, intensity, energy, and gradient of protons, alpha particles, and heavier nuclei, in interplanetary space.

DESCRIPTION: This instrument can identify nuclei of elements up to silicon over a wide range of speeds. It is composed of seven radiation detectors and associated logic circuitry arranged to provide five telescopes with fifteen discrete energy windows. The telescopes effectively cover the energies greater than 13.9 MeV for protons and alpha particles and from about 0.35 to 8.40 MeV for electrons. The instrument has an unrestricted viewing cone of approximately 60° with its centerline in a plane normal to the spacecraft spin axis. The detectors respond to incident radiation in one of three modes; normal, flare, and sectored-flare. The outputs are processed according to particle energy, incidence, time, and direction of flight. These pulse height analyzed data permit discrimination between nuclei of different elements. The resulting data are conditioned and formatted for presentation to the spacecraft's digital telemetry system. The instrument is mounted on the equipment platform and has an opening in the viewing band of approximately 71 cm^2 (11 sq in.).

PARAMETER SUMMARY:

Dimensions:	25.9 x 16.5 x 12.9 cm (10.2 x 6.5 x 5.1 in.)
Weight:	3.6 kg (8.0 lbs)
Power:	3.1 W
Range:	1 MeV to 1 BeV

Detectors:	Lithium-drifted solid state
Cerenkov Crystal:	7.7 cm diameter x 1 cm thick disc of synthetic sapphire
SOURCE:	
Data:	Pioneer Program Specifications Booklets: PC-122.00-08 and PC-146.04. TRW, Pioneer Handbook (1965-1969), December, 1968.
Reference:	

EXPERIMENT CATEGORY:	Magnetic Field
DATE OF LAUNCH:	13 December 1967
INSTRUMENT NAME:	Single Axis Magnetometer
SPACECRAFT:	Pioneer 8
DESTINATION:	Heliocentric Orbit
PRINCIPAL INVESTIGATOR:	N.F. Ness, GSFC
INSTRUMENT CONTRACTOR:	Goddard Space Flight Center

PURPOSE: To measure sequentially the magnitude of the three orthogonal components of the interplanetary magnetic field.

DESCRIPTION: This instrument has a single fluxgate sensor and associated electronics. The sensor is mounted on the end of one of the three spacecraft booms where the residual magnetic field of Pioneer VI was less than 0.5 γ. It is aligned perpendicular to the boom axis and at an angle of 54° 45' to the plane containing the boom and spin axis. Thus, at any three positions separated by 120° of spacecraft rotation, the sensor direction at one position is orthogonal to that at the other two positions. The sensor consists of a saturable magnetic core which is excited at 13 kHz from positive to negative saturation by a solenoidal drive coil. The magnitude of the second harmonic 26 kHz signal measured by a tuned amplifier connected to a secondary coil winding is proportional to the component of the external magnetic field along the sensor axis and the permanent magnetization of the core itself. A mechanical flip mechanism which rotates the sensor through 180° permits detection and, thus, elimination of the latter effect. The flip mechanism contains 22 small squibs grouped in pairs for redundancy. Each squib of a pair when individually fired releases a spring with an escapement mechanism to reverse the direction of the sensor by precisely 180°. Each pair of squibs is activated by ground command.

PARAMETER SUMMARY:

Dimensions: 27.2 x 8.4 x 12.4 cm (10.7 x 3.3 x 4.9 in.); 203.2 cm (80 in.) from sensor to spacecraft axis of rotation.

Weight:	2.9 kg (6.4 lbs)
Power:	1.0 W
Range:	± 64 γ
SOURCE:	
Data:	Pioneer Program Specifications Booklets: PC-122.00-08 and PC-146.04. TRW, Pioneer Handbook (1965-1969), December, 1968.
Reference:	

EXPERIMENT CATEGORY:	Micrometeoroid
DATE OF LAUNCH:	13 December 1967
INSTRUMENT NAME:	Cosmic Dust Detector
SPACECRAFT:	Pioneer 8
DESTINATION:	Heliocentric Orbit
PRINCIPAL INVESTIGATOR:	O.B. Berg, GSFC
INSTRUMENT CONTRACTOR:	Goddard Space Flight Center

PURPOSE: To measure the momentum, energy, and distribution of minute meteoroids in interplanetary space.

DESCRIPTION: This instrument uses a three-element sensor designed to detect particles, measure their time and direction of flight between two reference points, and report the resultant impulsive force as they impact the sensor. The sensor consists of a front and rear thin film detector with a piezoelectric crystal microphone mounted on an impact plate. The front and rear detectors are physically spaced apart so that the measuring circuit can determine the particle time of flight. The crystal microphone is sensitive to mechanical vibration induced by particle impact for which output is a function of the momentum of a particle. An auxiliary microphone is provided to detect spurious noise signals caused by mechanical coupling. Data are derived from sensor measurements of particle momentum, velocity, energy, and mass, for particles of mass of 5 x 10^{-5} grams at velocities greater than 4 km/sec. These measurements are telemetered to Earth. The instrument is counted on the equipment platform and has an opening in the viewing band of approximately 168 cm^2 (26 sq in.). The instrument has an acceptance cone of approximately 122°.

PARAMETER SUMMARY:

Dimensions:	15.2 x 16.3 x 15.2 cm (6.0 x 6.4 x 6.0 in.)
Weight:	1.9 kg (4.3 lbs)

Power:	0.4 W
Range:	Mass greater than 5×10^{-5} grams
Acceptance Cone:	122°
SOURCE:	
Data:	Pioneer Program Specifications Booklets: PC-122.00-08 and PC-146.04. TRW, Pioneer Handbook (1965-1969), December, 1968.
Reference:	

EXPERIMENT CATEGORY:	Plasma
DATE OF LAUNCH:	13 December 1967
INSTRUMENT NAME:	Solar Plasma Detector
SPACECRAFT:	Pioneer 8
DESTINATION:	Heliocentric Orbit
PRINCIPAL INVESTIGATOR:	J.H. Wolfe, ARC
INSTRUMENT CONTRACTOR:	Ames Research Center

PURPOSE: To measure the energy spectrum, flux and angular distribution of both positive ions and electrons of the interplanetary plasma.

DESCRIPTION: This instrument is a quadrispherically shaped electrostatic spectrometer which is used to measure ions energy/unit charge in the range 200 to 15,000 V in 30 logarithmically spaced steps and electron energies from 14 to 1000 eV in 15 steps. Azimuthal flow directions are obtained by referencing the plasma instrument angular position to the spacecraft sun sensor "E" pulse. Polar flow directions are obtained by use of three current collectors, each of which views in different polar directions. The total angular acceptance of the three collectors cover the range from -80° to +80° in polar angle. This allows plasma measurements to be taken in all directions except for a 10° half angle cone at each spacecraft pole. The instrument is mounted on the equipment platform so that the sensor aperture protrudes beyond the viewing band closure. An opening of approximately 13 cm^2 (2 sq in.) in the viewing band is required. The instrument has an unobstructed viewing angle of 160° in a plane parallel to the spin axis.

PARAMETER SUMMARY:

Dimensions:	16.0 x 17.0 x 16.8 cm (6.3 x 6.7 x 6.6 in.)
Weight:	2.7 kg (5.9 lbs)
Power:	3.9 W

Ranges: Energy/Charge
Positive Ions - 0.2 to 15 kV (30 bands)
Electrons - 0.014 to 1 kV (15 bands)
Flux Sensitivity - 5 x 10^4 to 10^8 particles/cm^2 - sec.

SOURCE:

Data: Pioneer Program Specifications Booklets: PC-122.00-08 and PC-146.04.
TRW, Pioneer Handbook (1965-1969), December, 1968.

Reference:

EXPERIMENT CATEGORY:	Radio Frequency Propagation
DATE OF LAUNCH:	13 December 1967
INSTRUMENT NAME:	Radio Propagation
SPACECRAFT:	Pioneer 8
DESTINATION:	Heliocentric Orbit
PRINCIPAL INVESTIGATOR:	V.R. Eshleman, Stanford University
INSTRUMENT CONTRACTOR:	Stanford University

PURPOSE: To measure the relative phase-modulation relationships between the 49.8 and 423.3 MHz coherent carriers transmitted from the Stanford 45-meter (150 foot) dish antenna to the experiment receivers, permitting the determination of the value and time variation of the integrated electron density between the Earth and the spacecraft.

DESCRIPTION: This experiment consists of two ground-based transmitters operating into a 45-meter (150 foot) diameter parabolic antenna located on the Stanford campus, a dual channel, phase-locked-loop receiver aboard the spacecraft, the spacecraft telemetry, and the Deep Space Network. All of the elements of the system just described must operate simultaneously to provide a closed loop operation. The receivers are designed to measure the relative phase of the modulation envelopes of the two carrier frequencies which, since the higher frequency is relatively unaffected by the presence of ionization, provides a value for the integrated electron density. In addition, the rate of change of phase of one carrier with respect to the other is measured, thus accurately determining the time variation of the integrated electron density. Signal strength is also measured.

PARAMETER SUMMARY:

Dimensions:	17.0 x 15.2 x 17.0 cm (6.7 x 6.0 x 6.7 in.)
Weight:	2.9 kg (6.3 lbs)
Power:	1.6 W
Range:	

SOURCE:

Data: Pioneer Program Specifications Booklets: PC-122.00-08 and PC-146.04.
TRW, Pioneer Handbook (1965-1969), December, 1968.

Reference:

EXPERIMENT CATEGORY:	Electric Field
DATE OF LAUNCH:	8 November 1968
INSTRUMENT NAME:	Electric Field Detector
SPACECRAFT:	Pioneer 9
DESTINATION:	Heliocentric Orbit
PRINCIPAL INVESTIGATOR:	F.L. Scarf, TRW
INSTRUMENT CONTRACTOR:	TRW Systems

PURPOSE: To measure and identify short wavelength interplanetary proton and electron density irregularities which may cause scintillation, anomalous phase shifts and propagation delays of radio frequency signals.

DESCRIPTION: This instrument responds only to the electric field component of signals which arrive at the spacecraft parallel to the axis of the 423.3 MHz Stanford Radio Propagation antenna. The antenna is used as an unbalanced dipole feeding a broad bandwidth channel for noise survey; and a pair of narrow bandwidth channels centered on the nominal proton and electron frequencies for detection of plasma oscillations. The electric field components are filtered to allow detection in the range of 0.1 to 100 kHz while the 400 Hz and 22,000 Hz components are selected for amplitude measurement. The frequency and amplitude measurements are telemetered to Earth by the spacecraft.

PARAMETER SUMMARY:

Dimensions:	6.3 x 10.2 x 5.8 cm (2.5 x 4.0 x 2.3 in.)
Weight:	0.4 kg (0.9 lbs)
Power:	0.4 W
Range:	0.1 to 100 kHz

SOURCE:

Data: JPL, Technical Memorandum No. 33-426 Vol. IV, 15 November, 1970.
TRW, Pioneer Handbook (1965-1969), December, 1968.

Reference:

EXPERIMENT CATEGORY:	Ionizing Radiation, High Energy Charged Particles
DATE OF LAUNCH:	8 November 1968
INSTRUMENT NAME:	Cosmic Ray Anisotrophy Detector
SPACECRAFT:	Pioneer 9
DESTINATION:	Heliocentric Orbit
PRINCIPAL INVESTIGATOR:	K.G. McCracken, SCAS
INSTRUMENT CONTRACTOR:	Southwest Center for Advanced Studies

PURPOSE: To measure the arrival direction, mass, and energy/speed of both solar and galactic cosmic ray particles.

DESCRIPTION: This instrument is a multiple telescope detector system. It examines the anisotropic characteristics of the low energy portion of the solar and galactic cosmic radiation spectrum and analyzes its variations as to time, energy, and nuclear species. The instrument consists of a scintillator crystal, an anti-coincidence scintillator, two photomultiplier tubes, and associated electronics. The instrument has two detector assemblies mounted side-by-side at the front of the instrument housing and protruding through the spacecraft viewing band approximately 77 cm^2 (12 sq in.). The energy range for protons is from 5 to 90 MeV, and for alpha particles from 150 to 360 MeV. The detector view angle is a 107° cone and the instrument requires a window of approximately 40.0 cm^2 (6.2 sq in.).

PARAMETER SUMMARY:

Dimensions:	17.5 x 19.0 x 13.7 cm (6.9 x 7.5 x 5.4 in.)
Weight:	2.5 kg (5.6 lbs)
Power:	1.9 W
Ranges:	Protons - 5 to 90 MeV Alpha particles - 150 to 360 MeV
Detectors:	Solid state ionization chambers, one cesium iodide crystal

SOURCE:

Data: JPL, Technical Memorandum No. 33-426 Vol. IV, 15 November, 1970.
TRW, Pioneer Handbook (1965-1969), December, 1968.

Reference:

EXPERIMENT CATEGORY: Ionizing Radiation, High Energy Charged Particles

DATE OF LAUNCH: 8 November 1968

INSTRUMENT NAME: Cosmic Ray Gradient Detector

SPACECRAFT: Pioneer 9

DESTINATION: Heliocentric Orbit

PRINCIPAL INVESTIGATOR: W.R. Webber, University of Minnesota

INSTRUMENT CONTRACTOR: University of Minnesota

PURPOSE: To measure the quantity, intensity, energy and gradient of protons, alpha particles, and heavier nuclei, in interplanetary space.

DESCRIPTION: This instrument can identify nuclei of element up to silicon over a wide range of speeds. It is composed of seven radiation detectors and associated logic circuitry arranged to provide five telescopes with fifteen discrete energy windows. The telescopes effectively cover the energies greater than 13.9 MeV for protons and alpha particles and from about 0.35 to 8.40 MeV for electrons. The instrument has an unrestricted viewing cone of approximately 60° with its centerline in a plane normal to the spacecraft spin axis. The detectors respond to incident radiation in one of three modes; normal, flare, and sectored-flare. The outputs are processed according to particle energy, incidence, time, and direction of flight. These pulse height analyzed data permit discrimination between nuclei of different elements. The resulting data are conditioned and formatted for presentation to the spacecraft's digital telemetry system. The instrument is mounted on the equipment platform and has an opening in the viewing band of approximately 71 cm^2 (11 sq in.).

PARAMETER SUMMARY:

Dimensions: 25.9 x 16.5 x 12.9 cm (10.2 x 6.5 x 5.1 in.)

Weight: 3.6 kg (7.9 lbs)

Power: 2.8 W

Range: 1 MeV to 1 BeV

Detectors:	Lithium-drifted solid state
Cerenkov crystal:	7.7 cm diameter x 1 cm thick disc of synthetic sapphire

SOURCE:

Data:	JPL, Technical Memorandum No. 33-426 Vol. IV, 15 November 1970. TRW, Pioneer Handbook (1965-1969), December, 1968.

Reference:

EXPERIMENT CATEGORY:	Magnetic Field
DATE OF LAUNCH:	8 November 1968
INSTRUMENT NAME:	Triaxial Magnetometer
SPACECRAFT:	Pioneer 9
DESTINATION:	Heliocentric Orbit
PRINCIPAL INVESTIGATOR:	C.P. Sonett, ARC
INSTRUMENT CONTRACTOR:	Ames Research Center

PURPOSE: To measure simultaneously the three orthogonal components of the interplanetary magnetic field.

DESCRIPTION: This instrument is comprised of two separate assemblies, a fluxgate sensor package, which is mounted at the end of a 182.9 cm (6.0 ft) boom to reduce the influence of spacecraft induced fields, and an electronics package which is mounted within the spacecraft main structure. The sensor boom is extended in a line parallel to the plane of spacecraft rotation. The sensor package includes three orthogonal fluxgate sensors, a flipper mechanism, a temperature sensor, and a flip position sensor. Two of the fluxgate sensors are mounted parallel to the spacecraft Y-axis and the other parallel to Z or spin axis, are mounted on a 90° flip mechanism so that their positions can be interchanged. The flip mechanism is powered by two resistance heated bimetal motors. Each fluxgate sensor consists of an elongated permalloy loop core having a toroidally wound drive winding and external sense and feedback windings. The sensor assemblies are approximately 5.1 cm (2.0 in.) long and 1.3 cm (0.5 in.) in diameter. The major functions accomplished by the electronics package are the provision of the fundamental drive power having negligible 2nd harmonic content for exciting the fluxgate sensors, selection and amplification of the 2nd harmonic obtained from each sense winding, synchronous demodulation of these to provide analog outputs proportional to the magnetic field, analog to digital conversion, spacecraft spin demodulation of the outputs of the spin plane channels, digital filtering to match each of the five telemetry bit rates, and periodic sampling of the outputs at the telemetry rate and buffer storage of the samples prior to telemetry output.

PARAMETER SUMMARY:

Dimensions:	Electronics package - 7.4 x 15.2 x 25.4 cm (2.9 x 6.0 x 10.0 in.) Boom package - 10.7 x 9.6 cm diameter (4.2 x 3.8 in.) Sensor package - 10.9 x 9.6 cm diameter (4.3 x 3.8 in.)
Weight:	3.3 kg (7.2 lbs)
Power:	5.7 W, 7.9 W peak power, 9.1 W in flip/calib mode
Range:	± 200 Y with precision of ± 0.2 γ

SOURCE:

Data:	JPL, Technical Memorandum No. 33-426 Vol. IV, 15 November 1970. TRW, Pioneer Handbook (1965-1969), December, 1968.
Reference:	Philco Ford, Pioneer Magnetometer Final Report, 31 October 1969.

EXPERIMENT CATEGORY: Micrometeoroid

DATE OF LAUNCH: 8 November 1968

INSTRUMENT NAME: Cosmic Dust Detector

SPACECRAFT: Pioneer 9

DESTINATION: Heliocentric Orbit

PRINCIPAL INVESTIGATOR: O.B. Berg, GSFC

INSTRUMENT CONTRACTOR: Goddard Space Flight Center

PURPOSE: To measure the momentum, energy, and distribution of minute meteoroids in interplanetary space.

DESCRIPTION: This instrument uses a three-element sensor designed to detect particles, measure their time and direction of flight between two reference points, and report the resultant impulsive force as they impact the sensor. The sensor consists of a front and rear thin film detector with a piezoelectric crystal microphone mounted on an impact plate. The front and rear detectors are physically spaced apart so that the measuring circuit can determine the particle time of flight. The crystal microphone is sensitive to mechanical vibration induced by particle impact for which output is a function of the momentum of a particle. An auxiliary microphone is provided to detect spurious noise signals caused by mechanical coupling. Data are derived from sensor measurements of particle momentum, velocity, energy, and mass, for particles of mass of 5 x 10^{-5} grams at velocities greater than 4 km/sec. These measurements are telemetered to Earth. The instrument is mounted on the equipment platform and has an opening in the viewing band of approximately 168 cm^2 (26 sq in.). The instrument has an acceptance cone of approximately 122°

PARAMETER SUMMARY:

Dimensions: 15.2 x 16.3 x 15.2 cm (6.0 x 6.4 x 6.0 in.)

Weight: 1.9 kg (4.3 lbs)

Power: 0.5 W

Range: Mass greater than 5 x 10^{-5} grams

Acceptance Cone:	122°
SOURCE:	
Data:	JPL, Technical Memorandum No. 33-426 Vol. IV, 15 November 1970. TRW, Pioneer Handbook (1965-1969), December, 1968.
Reference:	

EXPERIMENT CATEGORY:	Plasma
DATE OF LAUNCH:	8 November 1968
INSTRUMENT NAME:	Solar Plasma Detector
SPACECRAFT:	Pioneer 9
DESTINATION:	Heliocentric Orbit
PRINCIPAL INVESTIGATOR:	J.H. Wolfe, ARC
INSTRUMENT CONTRACTOR:	Ames Research Center

PURPOSE: To measure the energy spectrum, flux and angular distribution of both positive ions and electrons of the interplanetary plasma.

DESCRIPTION: This instrument is a quadrispherically shaped electrostatic spectrometer which is used to measure ions energy/unit charge in the range of 200 to 15,000 V in 30 logarithmically spaced steps and electron energies from 14 to 1,000 eV in 15 steps. Azimuthal flow directions are obtained by referencing the plasma instrument angular position to the spacecraft Sun sensor "E" pulse. Polar flow directions are obtained by use of three current collectors, each of which views in different polar directions. The total angular acceptance of the three collectors cover the range from -80° to +80° in polar angle. This allows plasma measurements to be taken in all directions except for a 10° half angle cone at each spacecraft pole. The instrument is mounted on the equipment platform so that the sensor aperture protrudes beyond the viewing band closure. An opening of approximately 13 cm^2 (2 sq in.) in the viewing band is required. The instrument has an unobstructed viewing angle of 160° in a plane parallel to the spin axis.

PARAMETER SUMMARY:

Dimensions:	16.0 x 17.0 x 16.8 cm (6.3 x 6.7 x 6.6 in.)
Weight:	2.7 kg (5.9 lbs)
Power:	3.7 W

Range:	Energy/Charge Positive Ions - 0.2 to 15 kV (30 bands) Electrons - 0.014 to 1 kV (15 bands) Flux Sensitivity - 5 x 10^4 to 10^8 particles/cm^2 - sec.

SOURCE:

Data:	JPL, Technical Memorandum No. 33-426 Vol. IV, 15 November 1970. TRW, Pioneer Handbook (1965-1969), December, 1968.

Reference:

EXPERIMENT CATEGORY: Radio Frequency Propagation

DATE OF LAUNCH: 8 November 1968

INSTRUMENT NAME: Radio Propagation

SPACECRAFT: Pioneer 9

DESTINATION: Heliocentric Orbit

PRINCIPAL INVESTIGATOR: V.R. Eshleman, Stanford University

INSTRUMENT CONTRACTOR: Stanford University

PURPOSE: To measure the relative phase-modulation relationships between the 49.8 and 423.3 MHz coherent carriers transmitted from the Stanford 45-meter (150 ft) dish antenna to the experiment receivers, permitting the determination of the value and time variation of the integrated electron density between the Earth and the spacecraft.

DESCRIPTION: This experiment consists of two ground-based transmitters operating into a 45-meter (150 ft) diameter parabolic antenna located on the Stanford campus, a dual channel, phase-locked-loop receiver aboard the spacecraft, the spacecraft telemetry, and the Deep Space Network. All of the elements of the system just described must operate simultaneously to provide a closed loop operation. The receivers are designed to measure the relative phase of the modulation envelopes of the two carrier frequencies which, since the higher frequency is relatively unaffected by the presence of ionization, provides a value for the integrated electron density. In addition, the rate of change of phase of one carrier with respect to the other is measured, thus accurately determining the time variation of the integrated electron density. Signal strength is also measured.

PARAMETER SUMMARY:

Dimensions: 17.0 x 15.2 x 17.0 cm (6.7 x 6.0 x 6.7 in.)

Weight: 2.9 kg (6.4 lbs)

Power: 1.6 W

Range:

SOURCE:

Data: JPL, Technical Memorandum No. 33-426 Vol. IV, 15 November, 1970.
TRW, Pioneer Handbook (1965-1969), December, 1968.

Reference:

EXPERIMENT CATEGORY:	Infrared Radiometry
DATE OF LAUNCH:	24 February 1969
INSTRUMENT NAME:	Infrared Radiometer
SPACECRAFT:	Mariner 6
DESTINATION:	Planet Mars
PRINCIPAL INVESTIGATOR:	G. Neugebauer, C.I.T.
INSTRUMENT CONTRACTOR:	Santa Barbara Research Center

PURPOSE: To provide temperature measurements of the surface of Mars by detection of thermal radiation in the infrared portion of the electromagnetic spectrum.

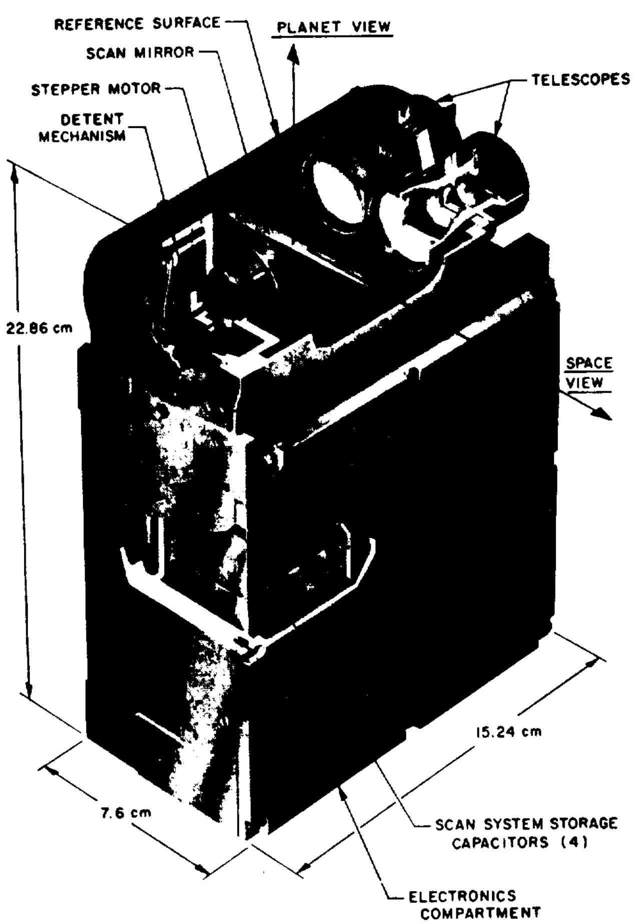
DESCRIPTION: Two detectors, antimony-bismuth 5-junction thermopile, in the instrument provide 30 readings every 63 seconds. The receptor surface is of gold and is 0.25 mm on a side. Channel 1 will cover the 8-12 micron wavelength range and Channel 2, 18-25 micron. The two channels, located in atmospheric "windows" emphasized the upper and lower temperatures of this range, respectively. The instrument package was located on the bottom of the octagonal scan platform of the spacecraft. The two refracting telescopes and an optical train which included a rotatable plane mirror were part of the instrument. The mirror reflected the incident energy into the detector telescopes. The mirror had three orthogonal positions. The first position viewed empty space and obtained a zero energy reference, the second viewed the planet, and the third measured the thermal energy radiated by a temperature calibration plate. After space was viewed for one frame count (4.2 sec), 13 observations of the planet were made at 2.1 sec intervals in each wavelength channel. Then, following a short look at the temperature reference plate, 14 more planetary observations were made. The cycle, which lasted 63 sec (15 frame counts), was then repeated, beginning with a view of space.

PARAMETER SUMMARY:

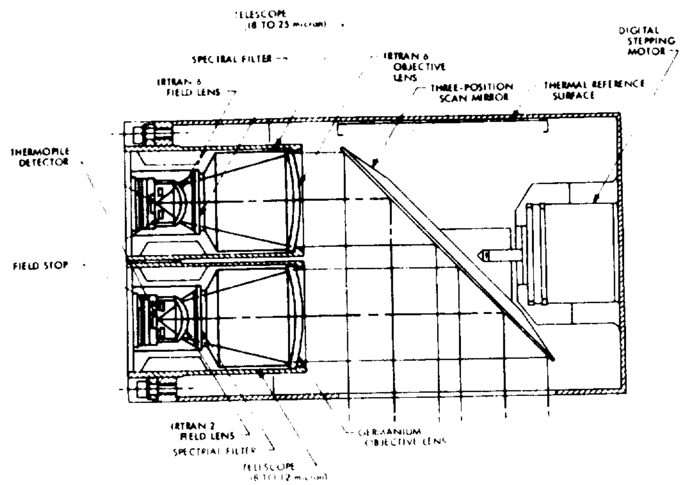
Dimensions:

Weight: 3.4 kg (7.5 lbs)

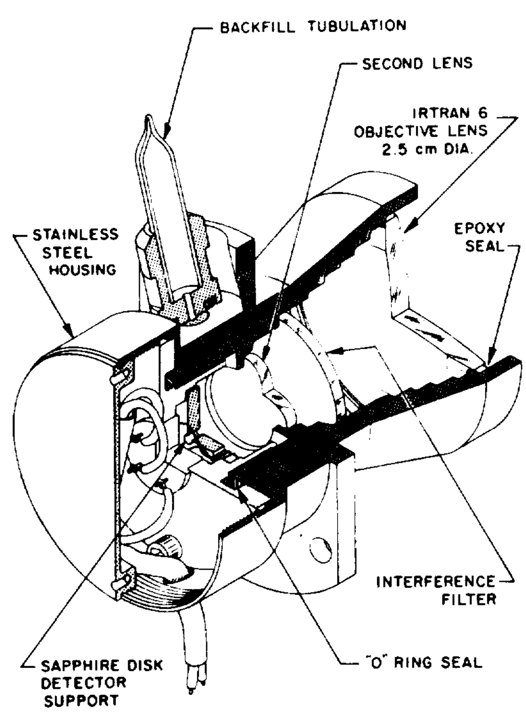
Power:	3W
Range:	8-12 and 18-25 microns
Detectors:	Antimony-bismuth 5-junction thermopile
Dynamic Range:	120-330° K
SOURCE:	
Data:	JPL Office of Public Information News Release, 14 February 1969. NSSDC AIM Printout (2 October 1972), ID No. 69-014A-03.
Reference:	



Mariner 6 Infrared Radiometer (Oblique View)



Mariner 6 Infrared Radiometer



Schematic Drawing of Telescope/Detector

EXPERIMENT CATEGORY: Infrared Spectrometry

DATE OF LAUNCH: 24 February 1969

INSTRUMENT NAME: Infrared Spectrometer

SPACECRAFT: Mariner 6

DESTINATION: Planet Mars

PRINCIPAL INVESTIGATOR: G.C. Pimentel, U.C./B.

INSTRUMENT CONTRACTOR: University of California at Berkeley

PURPOSE: To determine the presence in the lower Martian atmosphere of molecules that suggest biochemical processes, affect temperatures on the surface and limit the amount of ultraviolet reaching the surface; to detect variations in the composition of the atmosphere, particularly water vapor, relative to geographic locations.

DESCRIPTION: This instrument consists of a telescope, optical focusing lenses and mirrors, and two detectors. The Channel 1 detector is cooled by liquid hydrogen to below -400° F. The channel detector is cooled by a radiator plate which is exposed to the cold of space to maintain the detector at about -240° F. Rotating filters select wavelengths reaching the detectors. The filters assembly rotates every 10 seconds to complete one scan of the wavelength region being examined. The cooling system for the Channel 1 detector employs two 6,000 psi gas bottles storing hydrogen and nitrogen. Gas delivery to the cooling unit begins shortly before encounter. On command from the CC & S and a Mars sensor, explosive devices open valves to begin the gas flow. The same command will start the filter wheel motor.

PARAMETER SUMMARY:

Dimensions:

Weight: 16.3 kg (35.8 lbs)

Power: 8 W

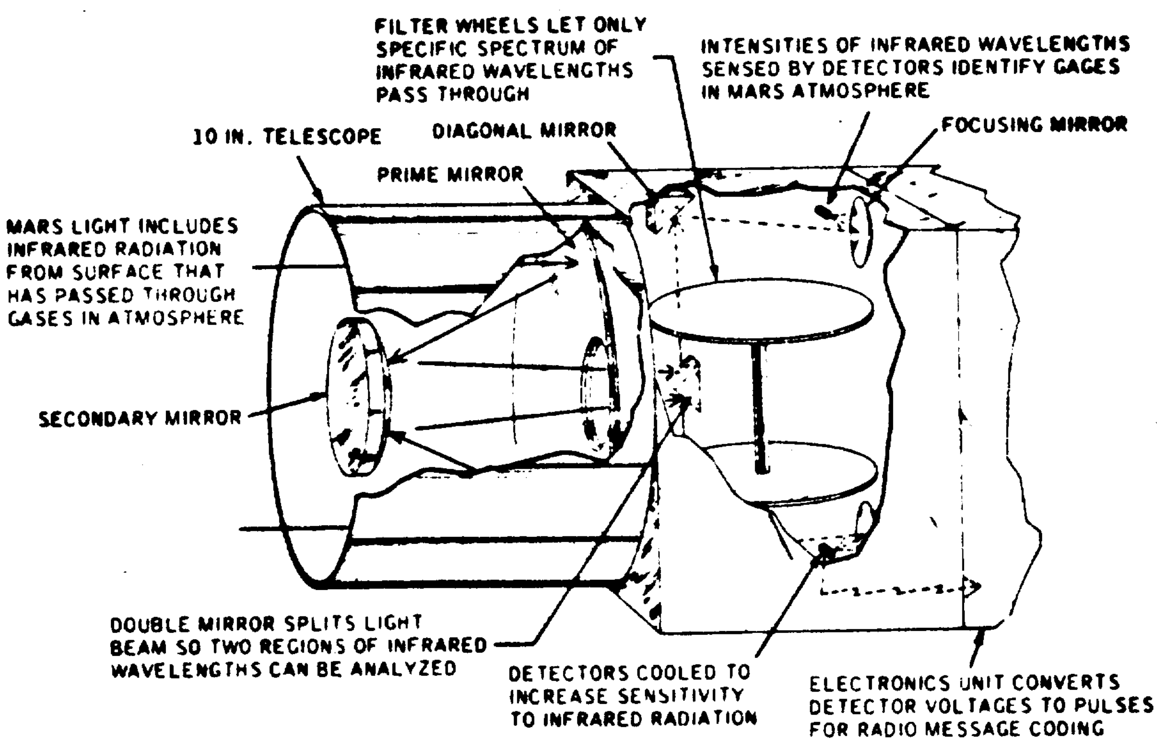
Range: Channel 1 - 4.0 to 14.3 microns
Channel 2 - 1.9 to 6.0 microns

Field of View:	2°
Geographical Resolution:	120 km x 3 km and 120 km x 120 km during a single scan
Spectral Resolution:	0.5 to 1%

SOURCE:

Data: JPL Office of Public Information News Release, 14 February 1969.
NSSDC AIM Printout (2 October 1972), ID No. 69-014A-02.

Reference:



Mariner 6 Infrared Spectrometer

EXPERIMENT CATEGORY:	Ultraviolet Spectrometry
DATE OF LAUNCH:	24 February 1969
INSTRUMENT NAME:	Ultraviolet Spectrometer
SPACECRAFT:	Mariner 6
DESTINATION:	Planet Mars
PRINCIPAL INVESTIGATOR:	C.A. Barth, University of Colorado
INSTRUMENT CONTRACTOR:	University of Colorado

PURPOSE: To identify gases in the upper Martian atmosphere by detection of various molecules, atoms and ions and to determine their amounts.

DESCRIPTION: Two-channel spectrometer, complete spectrum every ten seconds. It contains mirror elements, grating for diffraction of light, and two photomultiplier tubes for detection. A short-wavelength photometer sensitive in the 100 to 2150 Å range and a long-wave-length photometer detecting 1900 to 4300 Å radiation. The grating is ruled or grooved with 2160 rules per millimeter. It is mechanized to rotate. Ebert scanning spectrometer with an occulting slit telescope and a baffling system for the elimination of stray light. The design of the electronic subsystem allowed measurements of the Lyman-Alpha radiation (1216 Å) to be obtained before near encounter. The spectrometer scanned its range with a 3 sec period and gave a spectrum with a 20 Å resolution.

PARAMETER SUMMARY:

Dimensions:

Weight:

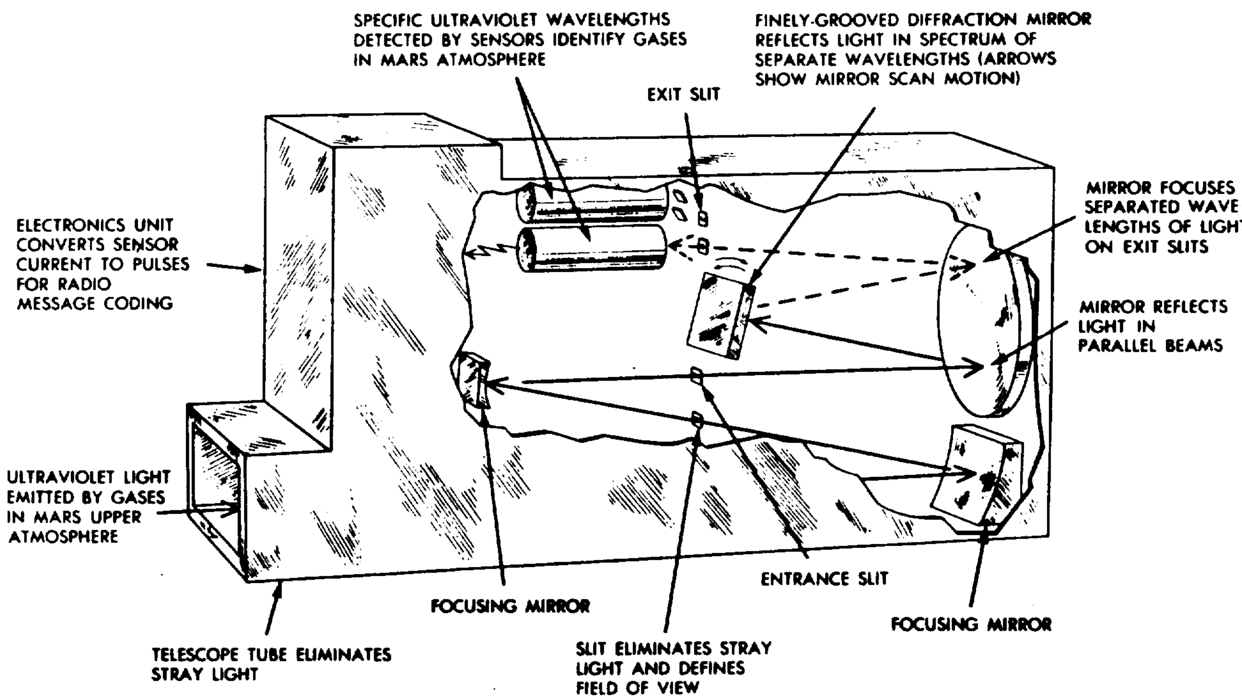
Power:

Range: 100 to 4300 Å

SOURCE:

Date: JPL Office of Public Information News Release, 14 February 1969.
NSSDC AIM Printout (2 October 1972), ID No. 69-014A-04.

Reference:



Mariner 6 Ultraviolet Spectrometer

EXPERIMENT CATEGORY: Visible Frequency, Camera

DATE OF LAUNCH: 24 February 1969

INSTRUMENT NAME: Television Cameras

SPACECRAFT: Mariner 6

DESTINATION: Planet Mars

PRINCIPAL INVESTIGATOR: R.B. Leighton, C.I.T.

INSTRUMENT CONTRACTOR:

PURPOSE: To photograph the surface and atmospheric features of as much of the planet as possible to determine if there are basic differences between light and dark areas, to learn more about the seasonally varying dark markings, and seek physical clues to the planet's origin and evolution.

DESCRIPTION: Two television cameras, one of medium (wide-angle) and the other of high (narrow-angle) resolution. The wide-angle camera's field of view is 10° x 14° and has a focal length of 50 mm. The camera encompassed 100 times more surface area than the narrow-angle camera. The narrow-angle camera has a focal length of 508 mm and provides 10 times the linear resolution of the wide-angle camera. Red, green, and blue filters are on the wide-angle camera to delineate color difference. Yellow filters on the narrow-angle camera reduce haze. The narrow-angle camera is equipped with a modified Schmidt Cassegrain telescope for approach pictures. The cameras operate alternately taking one picture every 84.48 sec. Resolution for the wide-angle camera is two miles and for the narrow-angle camera is 900 feet. The cameras have vidicon tubes with surfaces sensitive to light. Transmission to Earth is in binary form. Analog data stored in the analog recorder is converted before transmission. Binary coding is reconverted on Earth to electrical impulses and the impulses are used to modify the intensity of a beam of light which is swept across a 70 mm negative to expose it at 665,280 points to re-create the original image.

PARAMETER SUMMARY:

Dimensions:

Weight:

Power:

Range:

Filters: Red, Green, Blue, Yellow

Field of View: 10° x 14° (wide-angle camera)

SOURCE:

Data: JPL Office of Public Information News Release, 14 February 1969.
NSSDC AIM Printout (2 October 1972), ID No. 69-014A-01.

Reference:

EXPERIMENT CATEGORY:	Infrared Radiometry
DATE OF LAUNCH:	30 May 1971
INSTRUMENT NAME:	Infrared Radiometer
SPACECRAFT:	Mariner 9
DESTINATION:	Planet Mars
PRINCIPAL INVESTIGATOR:	G. Neugebauer, C.I.T.
INSTRUMENT CONTRACTOR:	Santa Barbara Research Center

PURPOSE: To provide temperature measurements of the surface of Mars by detection of thermal radiation in the infrared portion of the electromagnetic spectrum.

DESCRIPTION: This instrument is a two-channel, dichromic beamsplitter type interference-filter monochrometer. It has bimetallic thermopile detectors and it is boresighted with the TV camera. The 0.6 and 0.7° field of view provide a surface resolution of 13 and 15 km at a range of 1250 km. By using refractive optics, infrared radiation is focused on detectors, which use 13-junction bismuth-antimony thermopiles in two independent channels.

PARAMETER SUMMARY:

Dimensions:	
Weight:	3.0 kg (6.6 lbs)
Power:	
Range:	8 to 12 microns and 18 to 25 microns wavelength
Detectors:	13-junction bismuth-antimony thermopiles
Channels Field of View:	0.6° and 0.7°

Channels Resolutions:	13 and 15 km
Channels Range:	1250 km

SOURCE:

Data:

JPL, Mariner Mars 1971 Status Bulletin No. 41, 25 August 1972.

JPL, Mission to Mars, Mars Mariner 1971 Project, July, 1971.

JPL Office of Public Information News Release, 30 April 1971.

NSSDC AIM Printout (2 October 1972), ID No. 71-051A-01.

Reference:

EXPERIMENT CATEGORY:	Infrared Spectrometry
DATE OF LAUNCH:	30 May 1971
INSTRUMENT NAME:	Infrared Interferometer Spectrometer
SPACECRAFT:	Mariner 9
DESTINATION:	Planet Mars
PRINCIPAL INVESTIGATOR:	R.A. Hanel, NASA/GSFC
INSTRUMENT CONTRACTOR:	NASA/GSFC Texas Instruments

PURPOSE: To measure vertical structure, composition and dynamics of the atmosphere and the emissive properties of the Martian surface by measuring 6 to 50 micron radiation.

DESCRIPTION: This instrument is a Michelson-type interferometer spectrometer with a cesium iodide beamsplitter. The instrument has an electromagnetic mirror drive and a thermostated bolometer. It will resolve 1.5 cm E-1 using a scan rate of approximately 20 sec. The beamsplitter, which divides the incoming radiation into two approximately equal components. After reflection from the fixed and moving mirrors, respectively, the two beams are recombined and "interfere with each other" with a phase difference proportional to the optical path difference between both beams. The recombined components are focused on the detector, where the intensity is recorded as a function of path difference. Radiometrically accurate spectra are recovered by means of extensive computer processing on the ground. One spectrum (interferogram) will be recorded each 21 seconds.

PARAMETER SUMMARY:

Dimensions:	
Weight:	23.0 kg (50.6 lbs)
Power:	12 W average, 24 W peak
Range:	5 to 50 microns or 200 to 1600 cm^{-1}
Resolution:	1.5 cm E-1

Scan Rate: 20 sec

Spatial Resolution: 100 km for altitude of 1250 km 4.5° conical field of view

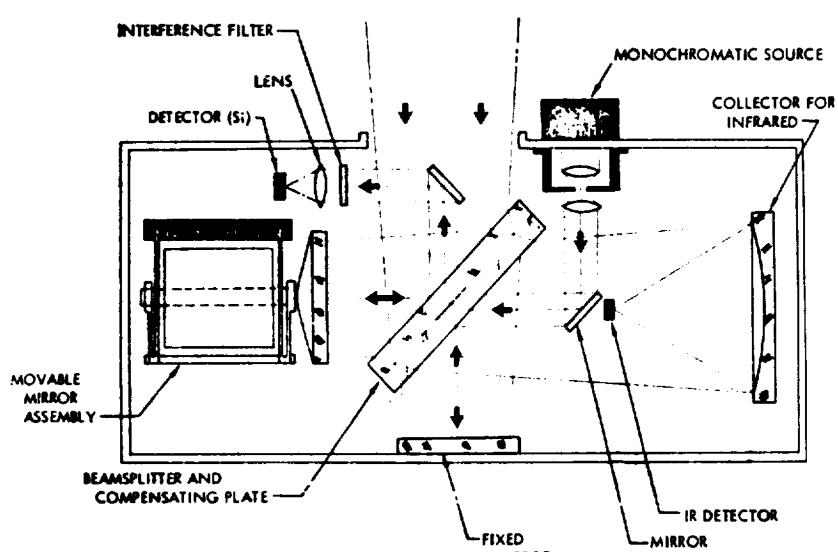
Wide Spectral Resolution Elements: 2.4 cm^{-1}

Field of View: 4.5°

SOURCE:

Data: JPL, Mariner Mars 1971 Status Bulletin No. 15, 9 November 1971.
JPL, Mission to Mars, Mars Mariner 1971 Project, July, 1971.
JPL Office of Public Information News Release, 30 April 1971.
NSSDC AIM Printout (2 October 1971), ID No. 71-051A-03.

Reference:



Mariner 9 Infrared Interferometer Spectrometer

EXPERIMENT CATEGORY:	Ultraviolet Spectrometry
DATE OF LAUNCH:	30 May 1971
INSTRUMENT NAME:	Ultraviolet Spectrometer
SPACECRAFT:	Mariner 9
DESTINATION:	Planet Mars
PRINCIPAL INVESTIGATOR:	C.A. Barth, University of Colorado
INSTRUMENT CONTRACTOR:	University of Colorado

PURPOSE: To map the surface and lower atmosphere in ultraviolet (ultraviolet cartography) and to study the temperature and structure in the upper atmosphere (ultraviolet aeronomy). To measure atmospheric radiation from resonance re-radiation, fluorescence, absorption, particle bombardment emission and scattering in the 1100 Å to 3500 Å range with 20 Å spectral resolution and 0.3° angular resolution.

DESCRIPTION: This instrument is a two-channel reflecting-grating spectrometer with an occulting-slit telescope and photomultiplier detectors. A surface resolution of 10 x 10 km is obtained at periapsis altitude of 200 km. The instrument is an Ebert-Fastie type of spectrometer. The optical view is a front surface mirror telescope through which ultraviolet light enters and is split into its component wavelengths by a reflection diffraction grating. Two exit slits allow two measurement channels. The detectors are photomultiplier tubes with specific photocathode and window materials that provide additional wavelength discrimination. The Channel 1 photomultiplier is an F tube with a spectral range of 1450-3500 Å. A step gain amplifier incorporated with this channel provides control over the expected range of surface brightness. The field of view is 0.20° x 0.50°. The Channel 2 photomultiplier tube (G) has a spectral range from 1100 Å to 1900 Å and a field of view of 0.20° x 1.25°. One spectral sweep of each channel will be recorded each three seconds.

PARAMETER SUMMARY:

Dimensions:

Weight: 16.0 kg (35.2 lbs)

Power:

Range: 1100 - 3500 Å

Spectral Resolution: 20 Å

Angular Resolution: 0.3°

Surface Resolution: 10 x 10 km

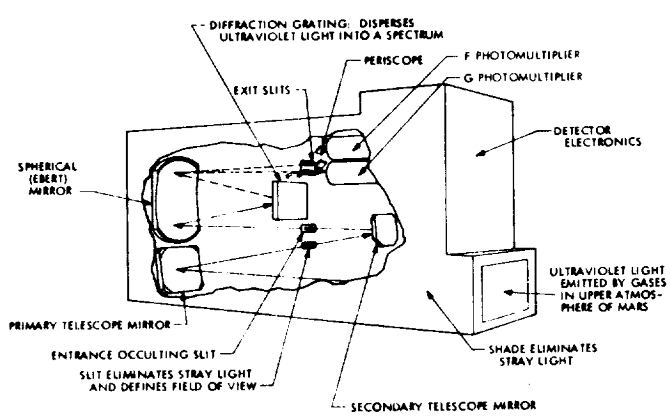
Periapsis Altitude: 200 km

SOURCE:

Data:

JPL, Mariner Mars 1971 Status Bulletin No. 12, 20 October 1971.
JPL, Mission to Mars, Mars Mariner 1971 Project, July, 1971.
JPL Office of Public Information News Release, 30 April 1971.
NSSDC AIM Printout (2 October 1972), ID No. 71-051A-02.

Reference:



Mariner 9 Ultraviolet Spectrometer

EXPERIMENT CATEGORY: Visible Frequency, Cameras

DATE OF LAUNCH: 30 May 1971

INSTRUMENT NAME: Television Cameras

SPACECRAFT: Mariner 9

DESTINATION: Planet Mars

PRINCIPAL INVESTIGATOR: H. Masursky, U.S. Geological Survey, Flagstaff, Ariz.

INSTRUMENT CONTRACTOR: Electro-Optical Systems, Pasadena, California

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PURPOSE: To map 70% of Mars at medium resolution and detailed studies of 5% at high resolution. To determine the shape of the planet, to arrive at high precision geodetic coordinates of a large number of well-defined topographic features for maps of the planet, to investigate, by photometric and photogrammetric analysis, surface slopes and relative elevation characteristics; to determine surface brightness and albedo differences; and to perform analyses related to improving the accuracy of the photometric function of Mars.

DESCRIPTION: Two cameras, one wide-angle and one narrow-angle. The wide-angle camera is equipped with commandable filters allowing a choice of eight filters. The vidicon used is a specialized version of a common photoconductive sensor. The key component of a vidicon is the target which consists of a transparent conductive coating on an optically flat faceplate covered by a thin film of a photosensitive semiconductor material. With the cameras pointed in the nadir direction (looking vertically downward at the surface) and the spacecraft at an altitude of 1250 km, the wide- and narrow-angle cameras can detect objects or features under about 1 km and 0.1 km, respectively. Focal ratio for the wide-angle camera is f/4.0, for the narrow-angle camera is f/2.35; automatic shutter speeds for the wide-angle camera are 48, 96, and 192 milliseconds, for the narrow-angle camera are 6, 12, and 24 milliseconds. Active vidicon target rater for both -9.6 mm x 12.5 mm. There are 700 scan lines per frame and 832 picture elements per line.

PARAMETER SUMMARY:

Dimensions:

Weight: 26.0 kg (57.2 lbs)

Power:

Range:

Field of View: Wide-angle camera - 11° x 14°
Narrow-angle camera - 1.1° x 1.4°

Periapsis Altitude: 2,000 km

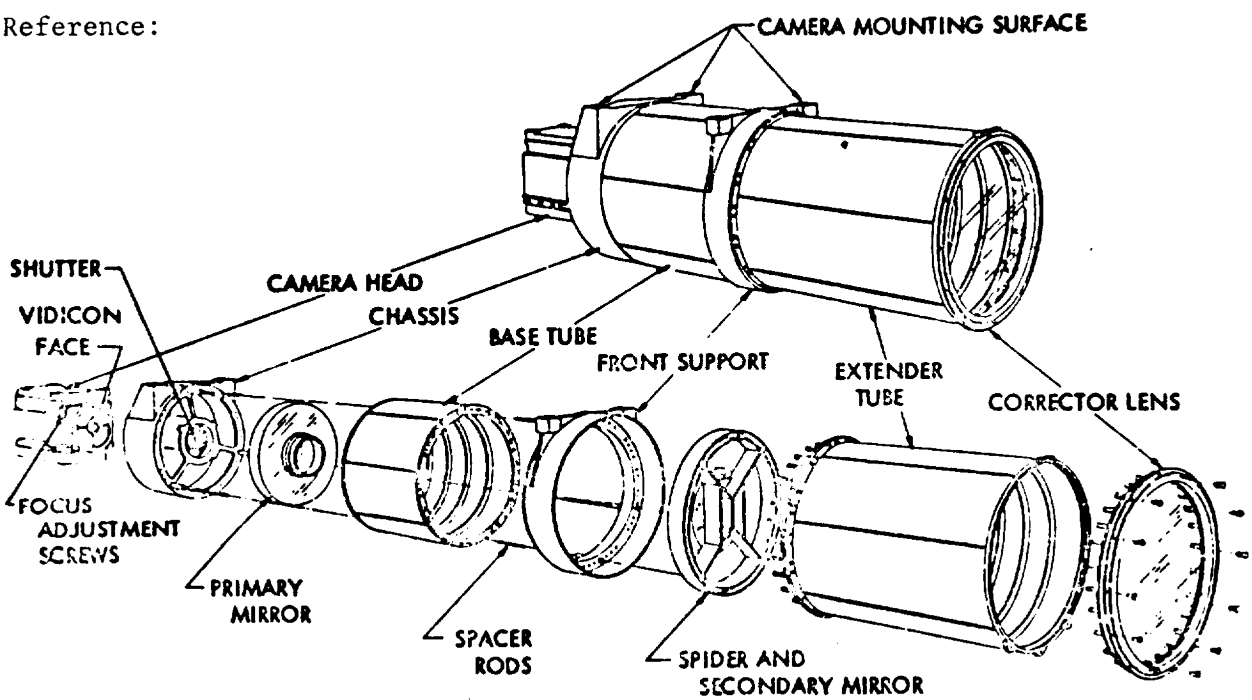
Focal Length: Wide-angle camera - 50 mm
Narrow-angle camera - 500 mm

Shutter Speed Range: 3 to 6,144 milliseconds

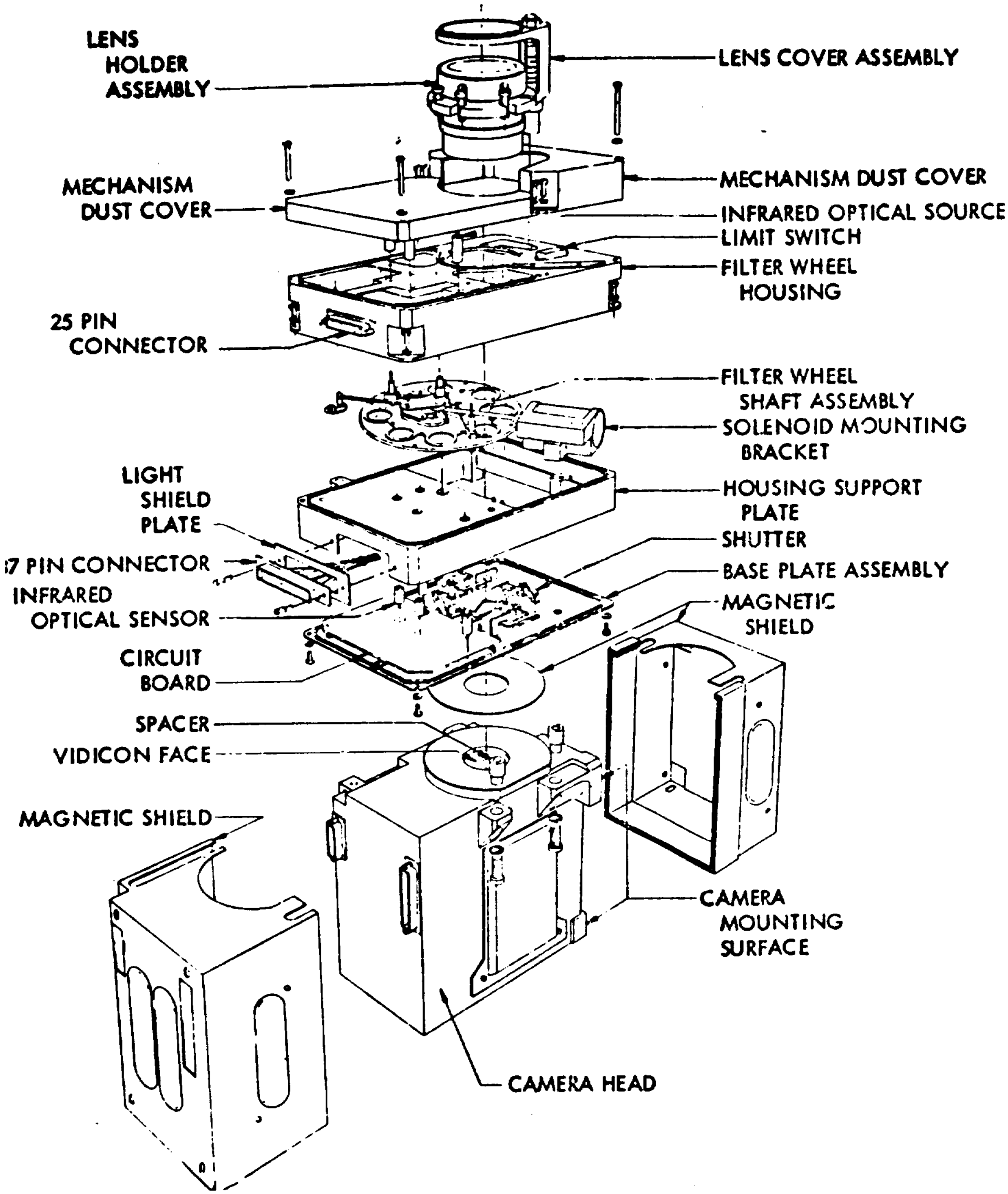
SOURCE:

Data: JPL Office of Public Information News Release, 30 April 1971.
JPL, Mission to Mars, Mars Mariner 1971 Project, July, 1971.

Reference:



Mariner 9 Narrow Angle Television Camera



Mariner 9 Wide Angle Television Camera

EXPERIMENT CATEGORY:	Infrared Radiometer
DATE OF LAUNCH:	2 March 1972
INSTRUMENT NAME:	Infrared Radiometer
SPACECRAFT:	Pioneer 10
DESTINATION:	Planet Jupiter
PRINCIPAL INVESTIGATOR:	G. Munch, C.I.T.
INSTRUMENT CONTRACTOR:	California Institute of Technology Santa Barbara Research Center

PURPOSE: To discover through measurement whether Jupiter is radiating a significant amount of internal energy, the temperature distribution in the outer-most atmospheric layers the existence of a polar ice cap due to frozen CH_4, the brightness temperature on the dark hemisphere, the existence of thermal inhomogeneities in the atmosphere, and the overall atmospheric H_2/He ratio.

DESCRIPTION: This instrument consists of a 2-channel infrared radiometer similar to those flown on Mariners 6 and 7. It employs a pair of 88-channel, thin-film, bimetallic thermopiles, illuminated through appropriate optics by a 7.6 cm (3 in.) reflecting Cassegrain telescope. Its effective field of view (EFOV) is $1^\circ \times 0.3^\circ$, corresponding to about 2400 x 700 km on the Jovian sphere and about 1/30 R_j resolution, at closest encounter (3 R_j). Known heat sources are automatically interposed into the field of view between planetary sweeps to calibrate each data cycle. The entire instrument, consisting of sensor and optics, calibrator, signal processing, logic, power, and interface circuitry, is packaged in a single housing, approximately 22.9 x 15.2 x 10.2 cm (9.0 x 6.0 x 4.0 in.) and weighing about 2.1 kg (4.7 lbs). The telescope protrudes from the package and through the side wall of the spacecraft equipment compartment to obtain the necessary planetary view angle.

PARAMETER SUMMARY:

Dimensions: 22.9 x 15.2 x 10.2 cm (9.0 x 6.0 x 4.0 in.)

Weight: 2.1 kg (4.7 lbs)

Power:	1.3 W
Illumination:	3 inch reflecting Cassegrain telescope
EFOV:	1° by 0.3°
SOURCE:	
Data:	Pioneer F/G Technical Plan, Pioneer Document P-201.
Reference:	

EXPERIMENT CATEGORY:	Ionizing Radiation
DATE OF LAUNCH:	2 March 1972
INSTRUMENT NAME:	Geiger-Tube Telescope
SPACECRAFT:	Pioneer 10
DESTINATION:	Planet Jupiter
PRINCIPAL INVESTIGATOR:	J.A. Van Allen, University of Iowa

PURPOSE:

To improve basic understanding of the origin and nature of planetary radiation belts, to find a basis for interpreting decimetric and (possibly) decametric radio emissions of Jupiter, to set parametric limits on magnitude, orientation and eccentricity of Jupiter's Magnetic moment, to define radiation environment for future missions to Jupiter, and to improve understanding of solar and galactic cosmic radiation beyond 2 astronomical units.

DESCRIPTION:

This instrument consists of six miniature Geiger-Muller tube detectors, each with an effective cylindrical volume about 0.15 cm in diameter and 0.8 cm in length, arranged to two arrays, and a seventh miniature Geiger-Muller tube detector with a mica window, scatter detector. Detectors A, B, and C are arranged in a linear array to form a 3 element coincidence telescope, enclosed by a 7 gm/cm^2 lead shield with an open front aperture affording ±15° x ±30° effective field of view (EFOV). Outputs are single counts A, B and C, double coincidence AB, and triple coincidence ABC. Useful dynamic range extends from 0.2 to 1 x 10^6 counts per second for individual tubes, and from 0.01 to 2 x 10^4 counts per second for the coincidence conditions. Detectors D, E and F are arranged in a triangular array and fully enclosed in a 7 gm/cm^2 lead shield to form a show detector. Outputs D and DEF are processed to compare individual primary events with secondary showers. Detector G is configured as a scatter detector, using a gold scatter target and a thin mica window, affording a 60° full angle view cone. The 3 detector assemblies, their associated signal processing, logic, interface, control and power circuitry are contained in a single housing about 15.2 x 10.2 x 12.7 cm (6.0 x 4.0 x 5.0 in.) The instrument weighs about 1.5 kg (3.2 lbs) and is located in the spacecraft's equipment compartment. The two detector telescopes with

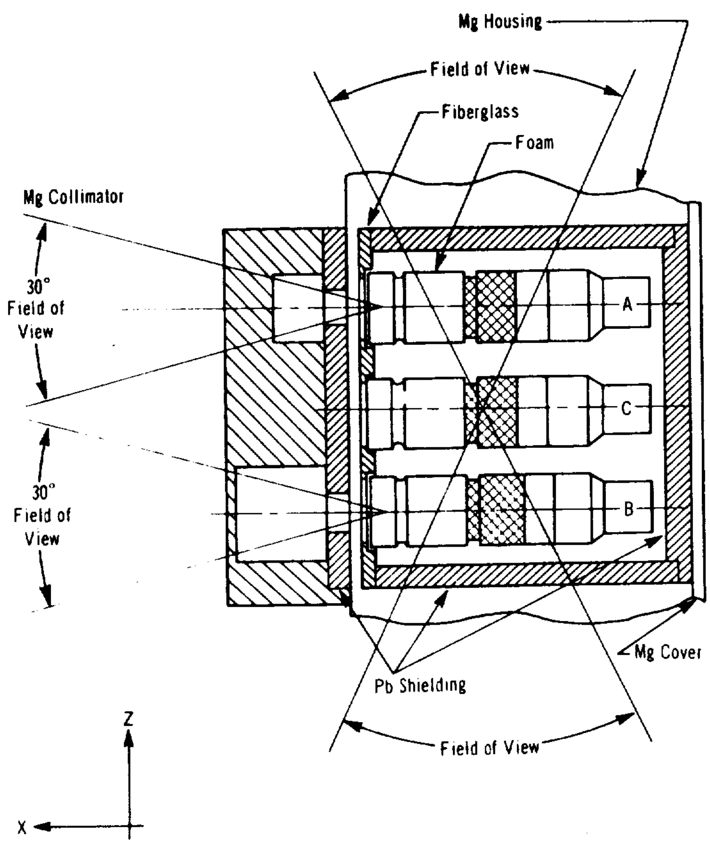
with apertures protrude from the housing and through ports in the spacecraft wall. The instrument uses about 0.8 W of power on a steady basis.

PARAMETER SUMMARY:

Dimensions:	15.2 x 10.2 x 12.7 cm (6.0 x 4.0 x 5.0 in.)
Weight:	1.5 kg (3.2 lbs)
Power:	0.8 W
EFOV:	± 15° x ± 30°

SOURCE:

Data:	Pioneer F/G Technical Plan, Pioneer Document P-201
Reference:	



Pioneer 10 Geiger-Tube Telescope

EXPERIMENT CATEGORY: Ionizing Radiation

DATE OF LAUNCH: 2 March 1972

INSTRUMENT NAME: Trapped Radiation Detector

SPACECRAFT: Pioneer 10

DESTINATION: Planet Jupiter

PRINCIPAL INVESTIGATOR: R.W. Fillius, U.C.S.D.

INSTRUMENT CONTRACTOR: University of California at San Diego

PURPOSE: To measure protons and electrons believed to be trapped in the magnetic field of Jupiter and correlate such measurements with observed Jovian radio emissions, to measure the gross characteristics of the trapped radiation, including particle species, absolute intensities, angular distribution and energy spectra, and from comparison with the Earth's radiation belts, to infer the mechanisms governing the trapping of radiation in general.

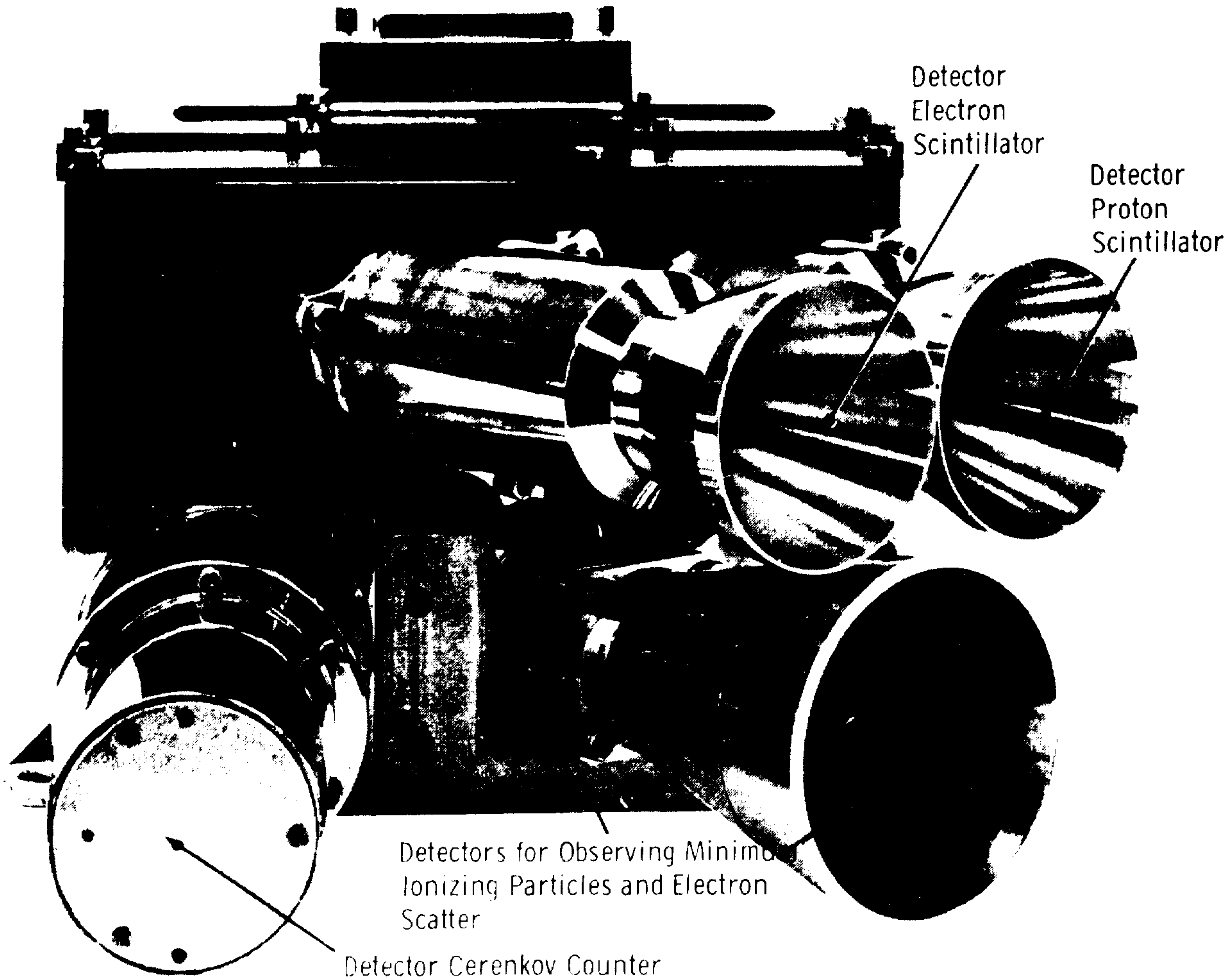
DESCRIPTION: This instrument consists of four detector assemblies. Detector C is a non-focused Cerenkov counter for energetic electrons, using an alcohol mass enclosed in a plastic can as the radiator optically coupled to a matched photomultiplier tube. Outputs will be discriminated into three pulse channels; 10, 30 and 75 photoelectrons threshold levels, and a DC channel monitoring total flux. The three channels correspond to electrons above 2 MeV, 5 MeV and 11 MeV, respectively. Proton threshold is approximately 450 MeV. The directional characteristics of the Cerenkov radiator provide a geometric factor of about 15 cm^2 ster. The DC channel window ranges from 10^{-11} to 10^{-5} amps, corresponding to electrons above 1.5 MeV. Detector E, a scatter detector for medium energy electrons, covers the electron energy range from 100 keV to 3 MeV. The detecting element is a totally-depleted surface barrier detector, with discrimination levels of 100 keV, 300 keV and 750 keV, with a mean geometric factor of about 1×10^{-4} cm^2 ster over the three ranges. Detector M is an omnidirectional counter for high energy protons and minimum ionizing particles. It consists of a solid state diode, embedded in the shield of Detector E, with discrimination levels set at 100 keV and 750 keV, for minimum ionizing particles and will be sensitive to high energy protons between 60 and 250 MeV, with omnidirectional geometric factor of 10^{-2} cm^2. Detector S, a scintillation detector for low energy particles, is a current-mode detector for electrons above 5 keV and protons above 50 keV without particle discrimination. It consists of a thin disc of scintillating material monitored by a vacuum photodiode. Its geometric factor is about 1 cm^2 ster. Its sensitivity, limited by the photodiodes dark current, is about 10^{-11} amps, giving a dynamic range from about 5×10^{11} to 10^{17} ev cm^{-2} sec^{-1} $ster^{-1}$. The four detectors with associated electronics are contained in a single housing located in the spacecraft equipment compartment, about 12.7 x 15.2 x 15.2 cm (5.0 x 6.0 x 6.0 in.) with detectors protruding from the housing and through the spacecraft wall to achieve required view angles. Total weight is 1.5 kg (3.3 lbs) and total power required is 1.9 W, continuous.

PARAMETER SUMMARY:

Dimensions:	12.7 x 15.2 x 15.2 cm (5.0 x 6.0 x 6.0 in.)
Weight:	1.5 kg (3.3 lbs)
Power:	1.9 W

SOURCE:

Data:	Pioneer F/G Technical Plan, Pioneer Document P-201.
Reference:	



Pioneer 10 Trapped Radiation Detector

EXPERIMENT CATEGORY: Ionizing Radiation, High Energy Charged Particles

DATE OF LAUNCH: 2 March 1972

INSTRUMENT NAME: Charged Particle Detectors

SPACECRAFT: Pioneer 10

DESTINATION: Planet Jupiter

PRINCIPAL INVESTIGATOR: J.A. Simpson, University of Chicago

INSTRUMENT CONTRACTOR: University of Chicago

PURPOSE: To map solar and galactic cosmic rays as to particle flux, energy spectra and distribution, to measure the radial gradients of interplanetary charged particles, traverse gradients, and anisotropy of particles. To examine solar particle propagation and acceleration phenomena over an extended time period and large solar range. To monitor interplanetary shock waves.

DESCRIPTION: This instrument consists of a 7 element charged particle telescope, a high intensity, high energy electron detector, a pair of solid state fission detectors, and a solid state proton detector. The charged particle telescope is a bidirectional linear array of five lithium-drifted solid state elements and one cesium-iodide scintillator and associated photodiode, surrounded by a plastic scintillator guard cylinder with associated photomultiplier tube. In addition to rate data, pulse height analysis is performed on selected events, according to a programmed priority scheme. Telescope range is 200 keV to 30 MeV for electrons, 450 keV to 150 MeV for protons and integral flux above 1 BeV/nucleon. The electron detector is designed to count high energy electrons in the Jovian radiation belts by Bremsstrahlung and direct interaction above 9 MeV. It consists of a gold-doped silicon element encased in a heavy lead "egg", functioning as a current-mode detector. The egg excludes protons below 50 MeV. Its dynamic range for a 4 pi geometric factor is 5×10^6 to 5×10^{11} electrons per second. The solid state fission detectors consist of target foils, of Bismuth 209 in one case, and Uranium 238 in the other, and gold-doped silicon curved surface detectors with very thin depletion depths. The proton detector is a linear array of two small solid state lithium-drifted detectors.

PARAMETER SUMMARY:

Dimensions:	22.9 x 17.8 x 22.9 cm (9.0 x 7.0 x 9.0 in.)
Weight:	3.2 kg (7.0 lbs)
Power:	2.4 W
Detectors:	Lithium-drifted Gold-doped silicon
Telescope Range:	Electrons - 200 keV to 30 MeV Protons - 450 keV to 150 MeV Intregal Flux - above 1 BeV/nucleon

SOURCE:

Data:	Pioneer F/G Technical Plan, Pioneer Document P-201.
Reference:	

EXPERIMENT CATEGORY:	Ionizing Radiation, High Energy Charged Particles
DATE OF LAUNCH:	2 March 1972
INSTRUMENT NAME:	Cosmic Ray Telescope
SPACECRAFT:	Pioneer 10
DESTINATION:	Planet Jupiter
PRINCIPAL INVESTIGATOR:	F.B. McDonald, NASA/GSFC
INSTRUMENT CONTRACTOR:	NASA/GSFC

PURPOSE: To measure the flow patterns of energetic solar and galactic particles with selectivity in the interplanetary field, to measure the energy spectrum, radial gradient, angular distribution, and streaming parameters for each nuclear species, over as wide an energy range as possible, to measure the energy spectra and isotopic composition of galactic and solar cosmic rays up to 800 MeV/nucleon, to measure time variations of the differential energy spectra of electrons, hydrogen and helium nuclei over the corresponding energy intervals, to study the energy spectra, time variations and spatial gradients associated with recurrent, non-flare-associated interplanetary proton and helium streams and define the particle acceleration processes, to examine the energetic particle distribution around Jupiter, and to attempt to determine the extent of the solar cavity, examine the boundary phenomena at the interface and the cosmic ray density in nearby interstellar space.

DESCRIPTION: This instrument includes three solid state telescopes. The high energy telescope has a three element linear array consisting of two single lithium-drifted detectors and a pack of 5 lithium-drifted detectors operating on penetrating and stopping particles. For penetrating particles, differential energy spectra are obtained for He and H_2 from 50-800 MeV/nucleon. For stopping particles, the range extends from 22-50 MeV/nucleon. One low energy telescope has a 3 element dE/dX versus $\dot{E}$ linear array, responding to protons and heavier nuclei from 3 to 22 MeV/nucleon, and provides both energy spectra and angular distribution over this range. The front element is a pair of silicon surface barrier detectors, the second element is a lithium-drifted silicon detector measuring total energy, and the third element is a lithium-drifted silicon detector serving as an anticoincidence element. A second low energy telescope has a three element linear array designed primarily to study solar radiation. The first element is a silicon surface, barrier type detector, the second and third are lithium-drifted silicon detectors. The first detector will stop electrons in the 50-150 keV range, and protons in the 50 keV-3 MeV range. The second detector will respond to electrons in the interval 150 keV - 1 MeV and protons between 3 MeV and 20 MeV. The third element serves as an anticoincidence guard. A suitable lead shield for radiation from the spacecraft (RTG's) is used to reduce the background count for the second low-energy telescope. The three telescopes and their associated electronics are contained in a single housing located on the upper shelf of the experiment compartment.

PARAMETER SUMMARY:

Dimensions:	15.2 x 16.5 x 20.3 cm (6.0 x 6.5 x 8.0 in.)
Weight:	3.1 kg (6.9 lbs)
Power:	2.2 W
Detectors:	Lithium-drifted silicon
High Energy Telescope Range:	Penetrating particles - 50 - 800 MeV/nucleon Stopping Particles - 22 - 50 MeV/nucleon
Low Energy Telescopes Range:	Telescope A - 3 - 22 MeV/nucleon Telescope B First Detector - electrons - 50 - 150 keV protons - 50 keV - 3 MeV Second Detector - electrons - 150 keV - 1 MeV protons - 3 - 20 MeV

SOURCE:

Data:	Pioneer F/G Technical Plan, Pioneer Document P-201.
Reference:	

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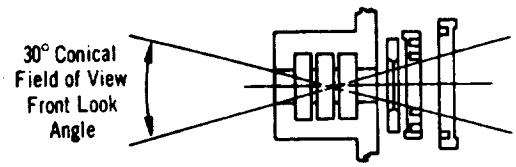
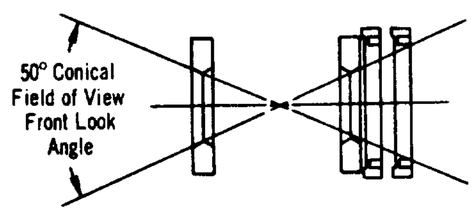
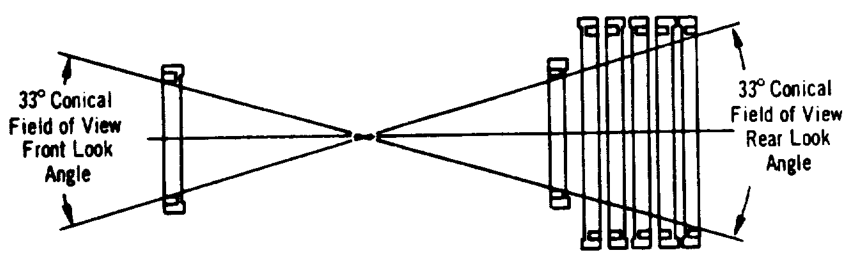


Low Energy Telescope



Low Energy Telescope



High Energy Telescope

Pioneer 10 Cosmic Ray Telescope

EXPERIMENT CATEGORY:	Magnetic Field
DATE OF LAUNCH:	2 March 1972
INSTRUMENT NAME:	Helium Vector Magnetometer
SPACECRAFT:	Pioneer 10
DESTINATION:	Planet Jupiter
PRINCIPAL INVESTIGATOR:	E.J. Smith, Jet Propulsion Lab
INSTRUMENT CONTRACTOR:	Jet Propulsion Lab Time Zero Corporation

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PURPOSE: To map the interplanetary magnetic field beyond 2 AU, to study the interaction of the solar wind with Jupiter's magnetosphere, to measure Jupiter's magnetic fields with sufficient precision to determine its source characteristics, to locate and to investigate the solar galactic boundary region.

DESCRIPTION: This instrument for Pioneer 10, an advanced version of those flown on Mariner IV and V, is an extremely stable, low-noise device for near-simultaneous measurement of the three axial components of the ambient magnetic field. It possesses the necessary sensitivity over the wide dynamic range needed to operate in both the very weak interplanetary fields at 5 AU and beyond, and in the strong planetary field of Jupiter, covering this range in eight selectable operating ranges from ± 2.5 gamma to ± 1.43 gauss. The helium vector magnetometer is a helium-filled cell subjected to RF excitation and infrared optical pumping. The gas exhibits variations in optical properties which are, in part, modulated by the ambient magnetic field, and this component of overall response can be extracted and phase detected to provide the desired axial field measurements. The sensor package, containing the helium cell, RF excitation, IR lamp and optics and the magnetic sweep drive components are enclosed in a cylindrical "coil cage" about 12.7 cm (5.0 in.) in diameter and 22.9 cm (9.0 in.) in length, and is mounted at the outboard end of a 6.0 m (20 ft) boom to separate it from spacecraft magnetic contributions. The electronics package, containing the signal processing logic and power circuitry, is an 20.3 x 12.7 x 10.2 cm (8.0 x 5.0 x 4.0 in.) box located within the spacecraft equipment compartment. The combined weight of sensor and electronics is 2.0 kg (4.5 lbs). The average power requirement is 3 W and the peak power requirement is 4.1 W during measurement of strong fields.

PARAMETER SUMMARY:

Dimensions: Coil Cage - 22.9 x 12.7 cm (9.0 x 5.0 in.), Electronics Package - 20.3 x 12.7 x 10.2 cm (8.0 x 5.0 x 4.0 in.), Boom - 6.0 m (20.0 ft)

Weight: 2.0 kg (4.5 lbs)

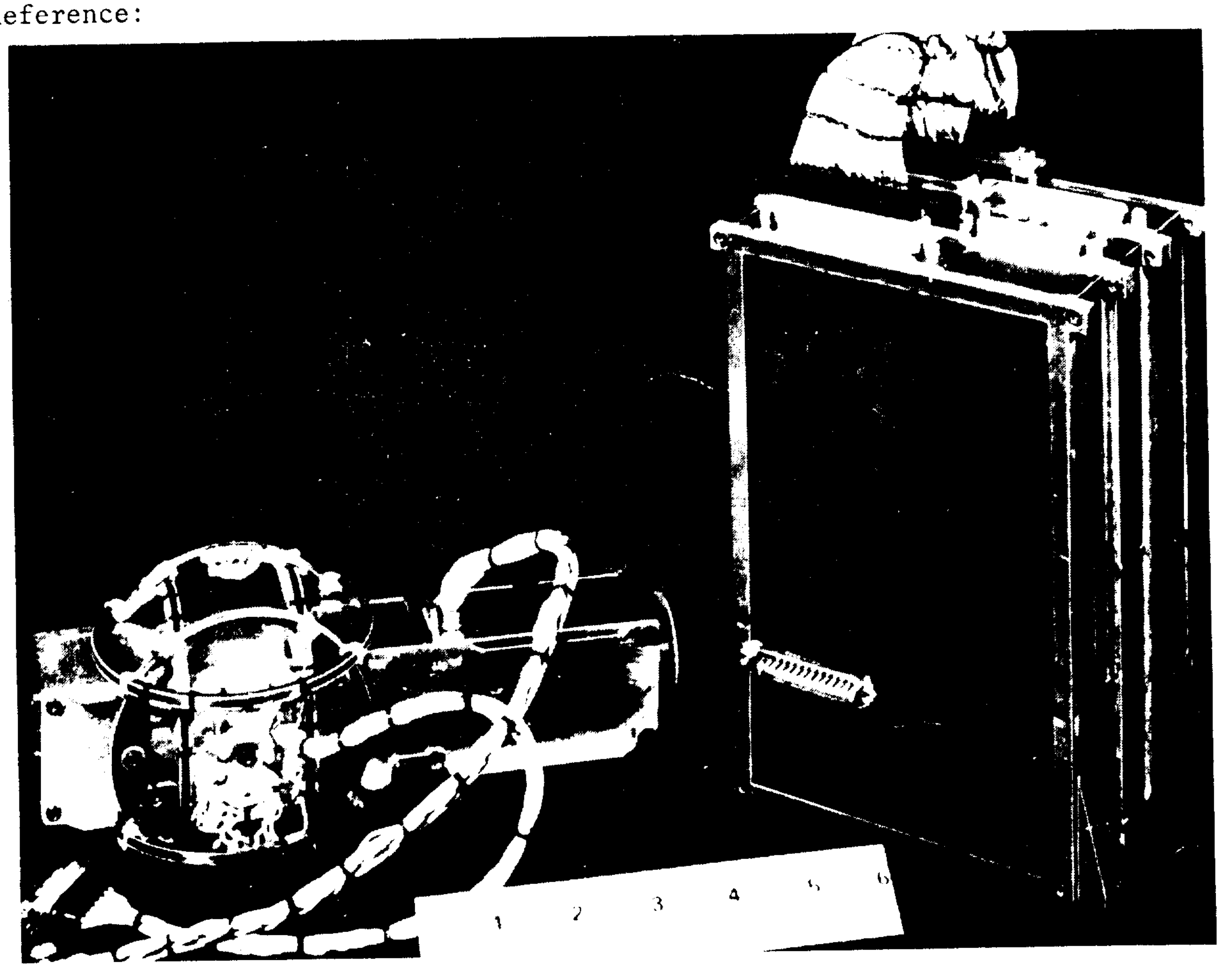
Power: 3 W average 4.1 W peak

Range: ± 2.5 gamma to ± 1.43 gauss

SOURCE:

Data: Pioneer F/G Technical Plan, Pioneer Document P-201.

Reference:



Pioneer 10 Helium Vector Magnetometer

EXPERIMENT CATEGORY: Micrometeoroid

DATE OF LAUNCH: 2 March 1972

INSTRUMENT NAME: Asteroid/Meteoroid Detector

SPACECRAFT: Pioneer 10

DESTINATION: Planet Jupiter

PRINCIPAL INVESTIGATOR: R.K. Soberman, G.E. Company

INSTRUMENT CONTRACTOR: General Electric Company

PURPOSE: To attempt to detect and measure parameters of asteroids and meteoroids as small as 1×10^{-6} grams mass, in the asteroid belt and interplanetary space, by optical sensing. Its objectives are to assess solid particle flux, mass properties, spectra, and velocities, and to contribute a basis for determining particulate origin and spatial distribution.

DESCRIPTION: This instrument consists of an array of four, independent, non-imaging, optical telescopes which detect asteroids and meteoroids by their reflected or scattered solar light. Each telescope consists of a 20.3 cm (8.0 in.) diameter, concave, hyperbolic, primary mirror, a 8.4 cm (3.3 in.) diameter, convex, hyperbolic, secondary mirror, suitable coupling optics and a 3.0 cm (1.2 in.) diameter photomultiplier tube. Each telescope forms a 10° view cone, the four view cones overlapping in part, to form regions of 2, 3 and 4-way coincidence. Photomultiplier output pulses are counted to determine flux. The particle range and velocity components are measured by timing entry and exit of reflections in the view cones. The instrument achieves a 0.2 radian instantaneous field of view (IFOV) and an overall resolution of 0.1 milliradians. A star-exclusion circuit serves to exclude "fixed" background except during in-flight calibrations and sky mapping. The instrument's 4 telescopes and their associated preamplifiers and power supplies are mounted on a special adapter panel outside the spacecraft equipment compartment to provide the needed view angles and freedom from scatter or reflection from spacecraft structure. The balance of the signal processing, logic, power, control and interface circuitry is contained in a 15.2 x 15.2 x 5.1 cm (6.0 x 6.0 x 2.0 in.) housing located within the equipment compartment.

PARAMETER SUMMARY:

Dimensions:	15.2 x 15.2 x 5.1 cm (6.0 x 6.0 x 2.0 in.)
Weight:	2.3 kg (5.1 lbs)
Power:	2 W
IFOV:	0.2 radian
Overall Resolution:	0.1 milliradians

SOURCE:

Data:	Pioneer F/G Technical Plan, Pioneer Document P-201.
Reference:	

EXPERIMENT CATEGORY:	Micrometeoroid
DATE OF LAUNCH:	2 March 1972
INSTRUMENT NAME:	Meteoroid Detector
SPACECRAFT:	Pioneer 10
DESTINATION:	Planet Jupiter
PRINCIPAL INVESTIGATOR:	W.H. Kinard, NASA/LRC
INSTRUMENT CONTRACTOR:	NASA/Langley Research Center

PURPOSE: To gain insight into flux levels, distribution and particulate size of meteoroids too small to detect readily by optical means, and to perform a preliminary study of the meteoroid penetration hazard to future spacecraft traversing the asteroid belt.

DESCRIPTION: This instrument consists of 12 banks of penetration cells, attached on standoffs to the spacecraft's exterior. Each bank is approximately 20.3 x 30.5 cm (8.0 x 12.0 in.) in size, constructed like an air mattress, with 18 individual cells in each bank. Each cell contains a pressure-sensitive transducer and is filled with neon prior to sealing. Penetration by a particle, in the mass range under study, causes a gradual pressure loss, with evacuation time ranging from a few seconds to as long as 30 minutes in duration. The transducer detects this pressure loss as a critical pressure is reached and a plasma discharge takes place across the cell. These events are counted to indicate meteoroid population and cell discharge timed to give an indication of penetration hole size and thus particle size and incident energy. The signal processing, logic, power and interface circuitry are contained in a housing 7.6 x 7.6 x 7.6 cm (3.0 x 3.0 x 3.0 in.), located in the spacecraft equipment compartment. Total weight of cell banks and electronics and interconnecting cabling is 1.8 kg (3.9 lbs). Average power required is 1 W.

PARAMETER SUMMARY:

Dimensions:	7.6 x 7.6 x 7.6 cm (3.0 x 3.0 x 3.0 in.)
Weight:	1.8 kg (3.9 lbs)

Power:	1 W
SOURCE:	
Data:	Pioneer F/G Technical Plan, Pioneer Document P-201.
Reference:	

EXPERIMENT CATEGORY:	Plasma
DATE OF LAUNCH:	2 March 1972
INSTRUMENT NAME:	Plasma Analyzer
SPACECRAFT:	Pioneer 10
DESTINATION:	Planet Jupiter
PRINCIPAL INVESTIGATOR:	J.H. Wolfe, ARC
INSTRUMENT CONTRACTOR:	Ames Research Center/NASA Time Zero Corporation

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PURPOSE: To measure spatial and temporal characteristics of the solar plasma as functions of heliocentric radial distance, to determine composition, energy distribution, ion and electron flux and energy spectra, to investigate the interaction of the solar wind with Jupiter's magnetosphere, and to search for and examine the solar/galactic boundary region.

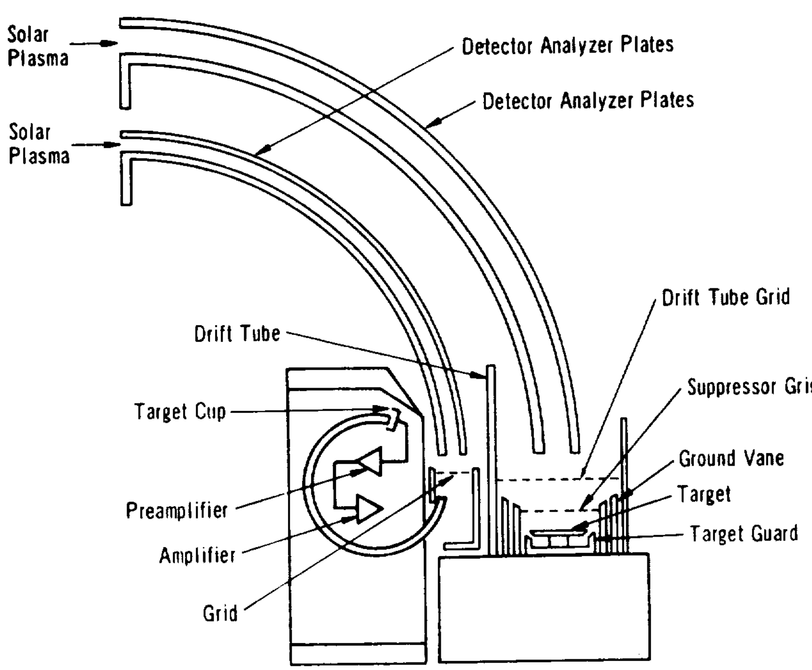
DESCRIPTION: This instrument consists of two concentric quadrispherical electrostatic plasma analyzers which measure ions and electrons as to direction of travel, energy and flux levels. Detector A consists of a pair of 90° quadrispherical plates with mean radius of 9 cm and plate separation of 0.5 cm. At the exit aperture a bank of 26 continuous-channel-multipliers, serving as "targets", is arranged to provide direction and energy measurements of incoming flux. Detector B consists of a similar pair of quadrispherical plates with mean radius of 12 cm and separation of 1.0 cm. A bank of 5 targets, each monitored by an electrometer amplifier, provides directional and energy measurement. The use of two curved plate detectors provides the necessary resolution over the wide range of particle energies, densities and incidence angles expected due to spacecraft orientation, view angle restrictions and non-thermal distributions caused by local particle acceleration. Detector A covers an ion energy range from 100 to 8,000 electron volts, in 16, 32 or 64 energy steps, depending on ground-commandable operating mode. Detector B covers an ion energy range from 100 to 8,000 eV, and an electron energy range from 1 to 500 eV in 32 or 64 steps and 16 steps, respectively.

PARAMETER SUMMARY:

Dimensions:	29.2 x 27.9 x 15.2 cm (11.5 x 11.0 x 6.0 in.)
Weight:	5.0 kg (11.0 lbs)
Power:	4.4 W
Field of View:	20° x 140° solar direction

SOURCE:

Data:	Pioneer F/G Technical Plan, Pioneer Document P-201.
Reference:	



Pioneer 10 Plasma Analyzer

EXPERIMENT CATEGORY:	Ultraviolet Photometry
DATE OF LAUNCH:	2 March 1972
INSTRUMENT NAME:	Ultraviolet Photometer
SPACECRAFT:	Pioneer 10
DESTINATION:	Planet Jupiter
PRINCIPAL INVESTIGATOR:	D.L. Judge, U.S.C.
INSTRUMENT CONTRACTOR:	University of Southern California Analog Technology Corporation

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PURPOSE: To determine the interplanetary neutral hydrogen density by observing its interaction with the solar wind over large solar distances by means of photometric measurements in the extreme uv range, to determine the radius of the heliosphere, the distance to the solar wind transition region, from precise measurements of the hydrogen distribution to 5 AU and beyond, to measure the H_2He ratio in the Jupiter atmosphere, to determine the temperature of the Jovian upper atmosphere, and to locate the Jovian day-side auroral "oval" by a UV photometric survey at encounter.

DESCRIPTION: This instrument is a single channel to uv photometer operating in the 200-800 Å range. Rejection of shorter and longer wavelengths is achieved with use of a thin aluminum mesh filter. The incident light is sensed by a lithium fluoride target cathode, 3.8 cm (1.5 in.) in diameter, which transmits an electron stream proportional to light intensity to a channeltron detector-amplifier. The sensor and all associated electronics are contained in a housing approximately 10.2 x 10.2 x 12.7 cm (4.0 x 4.0 x 5.0 in.), with a 7.6 cm (3.0 in.) diameter sensor tube protruding from the housing and through the spacecraft equipment platform approximately 10.2 cm (4.0 in.). Total weight of the unit is 0.7 kg (1.5 lbs). Power requirement is 1 W, continuous.

PARAMETER SUMMARY:

Dimensions:	10.2 x 10.2 x 12.7 cm (4.0 x 4.0 x 5.0 in.)
Weight:	0.7 kg (1.5 lbs)

Power:	1 W
Detector:	Channeltron
SOURCE:	
Data:	Pioneer F/G Technical Plan, Pioneer Document P-201.
Reference:	

EXPERIMENT CATEGORY:	Visible Frequency, Telescope
DATE OF LAUNCH:	2 March 1972
INSTRUMENT NAME:	Imaging Photopolarimeter
SPACECRAFT:	Pioneer 10
DESTINATION:	Planet Jupiter
PRINCIPAL INVESTIGATOR:	T. Gehrels, University of Arizona
INSTRUMENT CONTRACTOR:	University of Arizona Santa Barbara Research Center Dudley Observatory

PURPOSE: To perform zodiacal light mapping during the flight, to measure brightness and polarity of light over a wide range of scattering angles, to take photopolarization measurements of asteroids and solid particulate matter in the asteroid belt, and to perform two-color, visible-light imaging of Jupiter by spin-scan techniques during encounter.

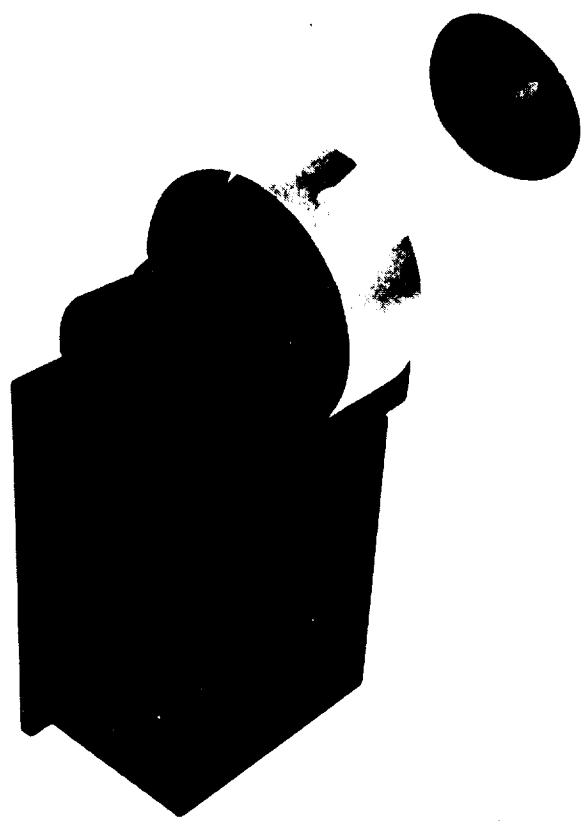
DESCRIPTION: This instrument consists of an optical telescope positioned by a spin-scan stepping motor, a beamsplitting optical prism, two sets of coupling and filtering optics, channeltron detectors, and signal processing, logic, control, interface and power circuitry. The telescope, which protrudes from the side of the spacecraft equipment compartment, provides an image with instantaneous field of view (IFOV) of 32 x 40 mrad for zodiacal light studies, 8 x 8 or 12 x 12 mrad (selectable by ground command) for photo polarimetry and 0.5 x 0.5 mrad for imaging. A Wallastron prism splits the image into two orthogonally polarized beams which are filtered to two-color channels; 3900-4900 Å (Blue) and 5800-7000 Å (Red). The spin-scan mechanism provides 0.5 milliradian scan angle stepping increments by ground command. Output from the channeltron detectors is processed and stored during the brief scan period for readout at spacecraft telemetry rates between scan periods.

PARAMETER SUMMARY:

Dimensions: 17.8 x 19.0 x 25.4 cm (7.0 x 7.5 x 10.0 in.)

Weight: 4.1 kg (9.0 lbs)

Power:	3.5 W average, 4.1 W peak
Telescope:	2.5 cm (1.0 in.) aperture, 8.6 cm (3.4 in.) focal length
IFOV:	32 x 40 milliradians for zodiacal light, 8 x 8 or 12 x 12 milliradians for photopolarimetry, and 0.5 x 0.5 milliradians for imaging.
Filters:	Blue (3900 to 4900 Å) and Red (5800 to 7000 Å)
Detectors:	Channeltron
SOURCE:	
Data:	Pioneer F/G Technical Plan, Pioneer Document P-201
Reference:	



Pioneer 10 Imaging Photopolarimeter

EXPERIMENT CATEGORY:	Infrared Radiometry
DATE OF LAUNCH:	April, 1973
INSTRUMENT NAME:	Infrared Radiomet
SPACECRAFT:	Pioneer 11
DESTINATION:	Planet Jupiter
PRINCIPAL INVESTIGATOR:	G. Munch, C.I.T.
INSTRUMENT CONTRACTOR:	California Institute of Technology Santa Barbara Research Center

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PURPOSE: To discover through measurement whether Jupiter is radiating a significant amount of internal energy, the temperature distribution in the outer-most atmospheric layers the existence of a polar ice cap due to frozen CH_4, the brightness temperature on the dark hemisphere, the existence of thermal inhomogeneities in the atmosphere, and the overall atmospheric H_2/He ratio.

DESCRIPTION: This instrument is a 2-channel infrared radiometer similar to those flown on Mariners 6 and 7. It employs a pair of 88-channel, thin-film, bimetallic thermopiles, illuminated through appropriate optics by a 3 inch reflecting Cassegrain telescope. Its effective field of view (EFOV) is $1^\circ \times 0.3^\circ$, corresponding to about 2400 x 700 km on the Jovian sphere and about 1/30 R_j resolution, at closest encounter (3 R_j). Known heat sources are automatically interposed into the field of view between planetary sweeps to calibrate each data cycle. The entire instrument, consisting of sensor and optics, calibrator, signal processing, logic, power, and interface circuitry, is packaged in a single housing, approximately 22.9 x 15.2 x 10.2 cm (9.0 x 6.0 x 4.0 in.) and weighing about 2.1 kg (4.7 lbs). The telescope protrudes from the package and and through the side wall of the spacecraft equipment compartment to obtain the necessary planetary view angle.

PARAMETER SUMMARY:

Dimensions: 22.9 x 15.2 x 10.2 cm (9.0 x 6.0 x 4.0 in.)

Weight: 2.1 kg (4.7 lbs)

Power: 1.3 W

Illumination: 3 inch reflecting Cassegrain telescope

EFOV: 1° by 0.3°

SOURCE:

Data: Pioneer F/G Technical Plan, Pioneer Document P-201.

Reference:

EXPERIMENT CATEGORY:	Ionizing Radiation
DATE OF LAUNCH:	April, 1973
INSTRUMENT NAME:	Geiger-Tube Telescope
SPACECRAFT:	Pioneer 11
DESTINATION:	Planet Jupiter
PRINCIPAL INVESTIGATOR:	J.A. Van Allen, University of Iowa
INSTRUMENT CONTRACTOR:	University of Iowa

PURPOSE: To improve basic understanding of the origin and nature of planetary radiation belts, to find a basis for interpreting decimetric and (possibly) decametric radio emissions of Jupiter, to set parametric limits on magnitude, orientation and eccentricity of Jupiter's magnetic moment, to define radiation environment for future missions to Jupiter, and to improve understanding of solar and galactic cosmic radiation beyond 2 AU.

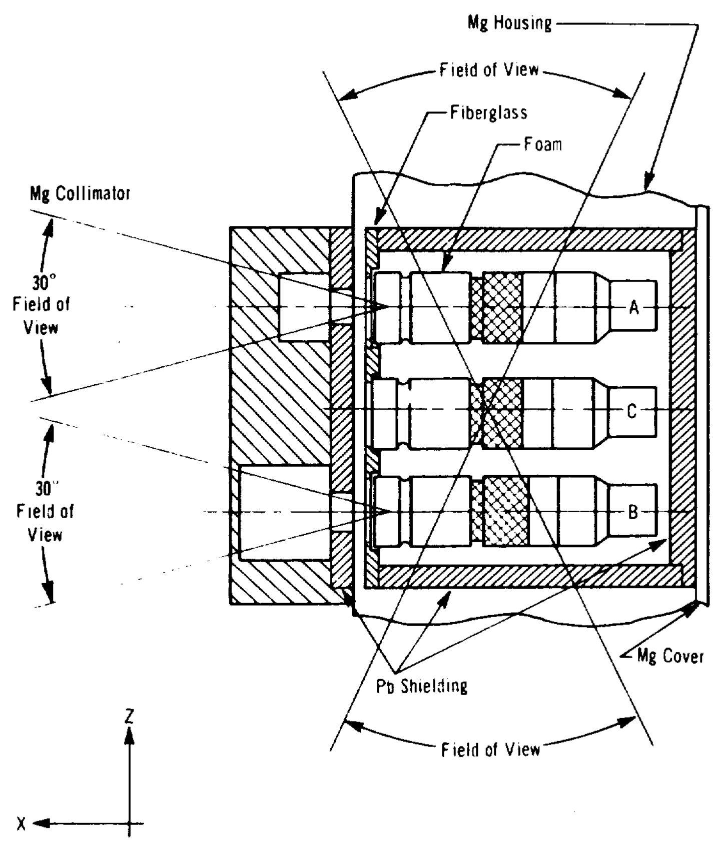
DESCRIPTION: This instrument consists of six miniature Geiger-Muller tube detectors, each with an effective cylindrical volume about 0.15 cm in diameter and 0.8 cm in length, arranged to two arrays, and a seventh miniature Geiger-Muller tube detector with a mica window, scatter detector. Detectors A, B and C are arranged in a linear array to form a 3 element coincidence telescope, enclosed by a 7 gm/cm^2 lead shield with an open front aperture affording a ± 15° by ± 30° effective field of view (EFOV). Outputs are single counts A, B and C, double coincidence AB, and triple coincidence ABC. Useful dynamic range extends from 0.2 to 1 x 10^6 counts per second for individual tubes, and from 0.01 to 2 x 10^4 counts per second for the coincidence conditions. Detectors D, E and F are arranged in a triangular array and fully enclosed in a 7 gm/cm^2 lead shield to form a shower detector. Outputs D and DEF are processed to compare individual primary events with secondary showers. Detector G is configured as a scatter detector, using a gold scatter target and a thin mica window, affording a 60° full angle view cone. The 3 detector assemblies, their associated signal processing, logic, interface, control and power circuitry are contained in a single housing about 15.2 x 10.2 x 12.7 cm (6.0 x 4.0 x 5.0 in.). The instrument weighs about 1.5 kg (3.2 lbs) and is located in the spacecraft's equipment compartment. The two detector telescopes with apertures protrude from the housing and through ports in the spacecraft wall. The instrument uses about 0.8 W of power on a steady basis.

PARAMETER SUMMARY:

Dimensions:	15.2 x 10.2 x 12.7 cm (6.0 x 4.0 x 5.0 in.)
Weight:	1.5 kg (3.2 lbs)
Power:	0.8 W
EFOV:	± 15° x ± 30°

SOURCE:

Data:	Pioneer F/G Technical Plan, Pioneer Document P-201.
Reference:	



Pioneer 11 Geiger-Tube Telescope

EXPERIMENT CATEGORY:	Ionizing Radiation
DATE OF LAUNCH:	April, 1973
INSTRUMENT NAME:	Trapped Radiation Detector
SPACECRAFT:	Pioneer 11
DESTINATION:	Planet Jupiter
PRINCIPAL INVESTIGATOR:	R.W. Fillius, U.C.S.D.
INSTRUMENT CONTRACTOR:	University of California at San Diego

PURPOSE: To measure protons and electrons believed to be trapped in the magnetic field of Jupiter and correlate such measurements with observed Jovian radio emissions, to measure the gross characteristics of the trapped radiation, including particle species, absolute intensities, angular distribution and energy spectra, and from comparison with the Earth's radiation belts, to infer the mechanisms governing the trapping of radiation in general.

DESCRIPTION: This instrument consists of four detector assemblies. Detector C is a non-focused Cerenkov counter for energetic electrons, using an alcohol mass enclosed in a plastic can as the radiator optically coupled to a matched photomultiplier tube. Outputs will be discriminated into three pulse channels; 10, 30 and 75 photoelectrons threshold levels, and a DC channel monitoring total flux. The three channels correspond to electrons above 2 MeV, 5 MeV and 11 MeV, respectively. Proton threshold is approximately 450 MeV. The directional characteristics of the Cerenkov radiator provide a geometric factor of about 15 cm^2 ster. The DC channel window ranges from 10^{-11} to 10^{-5} amps, corresponding to electrons above 1.5 MeV. Detector E, a scatter detector for medium energy electrons, covers the electron energy range from 100 keV to 3 MeV. The detecting element is a totally-depleted surface barrier detector, with discrimination levels of 100 keV, 300 keV, and 750 keV, with a mean geometric factor of about 1×10^{-4} cm^2 ster over the three ranges. Detector M is an omnidirectional counter for high energy protons and minimum ionizing particles. It consists of a solid state diode, embedded in the field of Detector E, with discrimination levels set at 100 keV and 750 keV, for minimum ionizing particles and will be sensitive to high energy protons between 60 and 250 MeV with omnidirectional geometric factor of 10^{-2} cm^2. Detector S, a scintillation detector for low energy particles, is a current-mode detector for electrons above 5 keV and protons above 50 keV without particle discrimination. It consists of a thin disc of scintillating material monitored by a vacuum photodiode. Its geometric factor is about 1 cm^2 ster. Its sensitivity, limited by the photodiodes dark current, is about 5×10^{11} to 10^{17} ev cm^{-2} sec^{-1} $ster^{-1}$. The four detectors with associated electronics are contained in a single housing located in the spacecraft equipment compartment, about 12.7 x 15.2 x 15.2 cm (5.0 x 6.0 x 6.0 in.) with detectors protruding from the housing and through the spacecraft wall to achieve required view angles. Total weight is 1.5 kg (3.3 lbs) and total power required is 1.9 W, continuous.

PARAMETER SUMMARY:

Dimensions: 12.7 x 15.2 x 15.2 cm (5.0 x 6.0 x 6.0 in.)

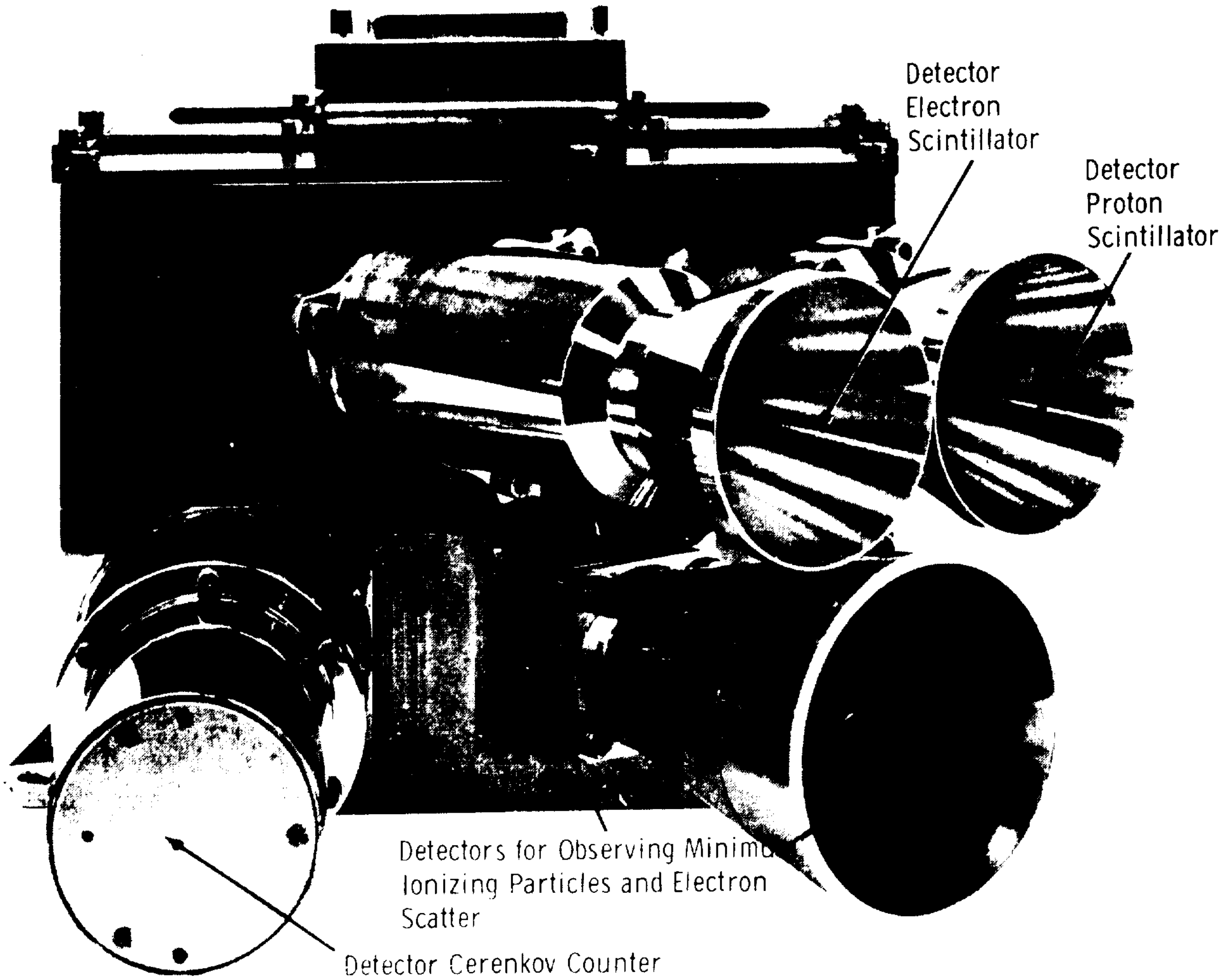
Weight: 1.5 kg (3.3 lbs)

Power: 1.9 W

SOURCE:

Data: Pioneer F/G Technical Plan, Pioneer Document P-201.

Reference:



Pioneer 11 Trapped Radiation Detector

EXPERIMENT CATEGORY: Ionizing Radiation, High Energy Charged Particles

DATE OF LAUNCH: April, 1973

INSTRUMENT NAME: Charged Particle Detectors

SPACECRAFT: Pioneer 11

DESTINATION: Planet Jupiter

PRINCIPAL INVESTIGATOR: J.A. Simpson, University of Chicago

INSTRUMENT CONTRACTOR: University of Chicago

PURPOSE: To map solar and galactic cosmic rays as to particle flux, energy spectra and distribution, to measure the radial gradients of interplanetary charged particles, traverse gradients, and anisotropy of particles. To examine solar particle propagation and acceleration phenomena over an extended time period and large solar range. To monitor interplanetary shock waves.

DESCRIPTION: This instrument consists of a seven element charged particle telescope, a high intensity, high energy electron detector, a pair of solid state fission detectors, and a solid state proton detector. The charged particle telescope is a bidirectional linear array of five lithium-drifted solid state elements and one cesium-iodide scintillator and associated photodiode, surrounded by a plastic scintillator guard cylinder with associated photomultiplier tube. In addition to rate data, pulse height analysis is performed on selected events, according to a programmed priority scheme. Telescope range is 200 keV to 30 MeV for electrons, 450 keV to 150 MeV for protons and integral flux above 1 BeV/nucleon. The electron detector is designed to count high energy electrons in the Jovian radiation belts by Bremsstrahlung and direct interaction above 9 MeV. It consists of a gold-doped silicon element encased in a heavy lead "egg", functioning as a current-mode detector. The egg excludes protons below 50 MeV. Its dynamic range for a 4 pi geometric factor is 5×10^6 to 5×10^{11} electrons per second. The solid state fission detectors consist of target foils, of Bismuth 209 in one case, and Uranium 238 in the other, and gold-doped silicon curved surface detectors with very thin depletion depths. The proton detector is a linear array of two small solid state lithium-drifted detectors.

PARAMETER SUMMARY:

Dimensions:	22.9 x 17.8 x 22.9 cm (9.0 x 7.0 x 9.0 in.)
Weight:	3.2 kg (7.0 lbs)
Power:	2.4 W
Detectors:	Lithium-drifted Gold-doped silicon
Telescope Range:	Electrons - 200 keV to 30 MeV Protons - 450 keV to 150 MeV Intregal Flux - above 1 BeV/nucleon

SOURCE:

Data:	Pioneer F/G Technical Plan, Pioneer Document P-201.
Reference:	

EXPERIMENT CATEGORY:	Ionizing Radiation, High Energy Charged Particles
DATE OF LAUNCH:	April, 1973
INSTRUMENT NAME:	Cosmic Ray Telescope
SPACECRAFT:	Pioneer 11
DESTINATION:	Planet Jupiter
PRINCIPAL INVESTIGATOR:	F.B. McDonald, NASA/GSFC
INSTRUMENT CONTRACTOR:	Goddard Space Flight Center

PURPOSE:

To measure the flow patterns of energetic solar and galactic particles with selectivity in the interplanetary field, to measure the energy spectrum, radial gradient, angular distribution, and streaming parameters for each nuclear species, over as wide an energy range as possible, to measure the energy spectra and isotopic composition of galactic and solar cosmic rays up to 800 MeV/nucleon, to measure time variations of the differential energy spectra of electrons, hydrogen and helium nuclei over the corresponding energy intervals, to study the energy spectra, time variations and spatial gradients associated with recurrent, non-flare-associated interplanetary proton and helium streams and define the particle acceleration processes, to examine the energetic particle distribution around Jupiter, and to attempt to determine the extent of the solar cavity, examine the boundary phenomena at the interface and the cosmic ray density in nearby interstellar space.

DESCRIPTION:

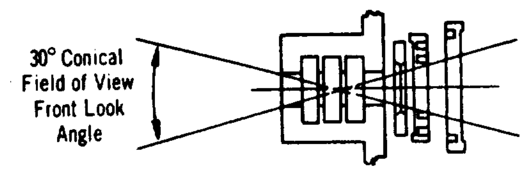
This instrument includes three solid state telescopes. The high energy telescope has a three element linear array consisting of two single lithium-drifted detectors and a pack of 5 lithium-drifted detectors operating on penetrating and stopping particles. For penetrating particles, differential energy spectra are obtained for He and H_2 from 50-800 MeV/nucleon. For stopping particles, the range extends from 22-50 MeV/nucleon. One low energy telescope has a 3 element dE/dX versus E linear array, responding to protons and heavier nuclei from 3 to 22 MeV/nucleon, and provides both energy spectra and angular distribution over this range. The front element is a pair of silicon surface barrier detectors, the second element is a lithium-drifted silicon detector measuring total energy, and the third element is a lithium-drifted silicon detector serving as an anticoincidence element. A second low energy telescope has a three element linear array designed primarily to study solar radiation. The first element is a silicon surface, barrier type detector, the second and third are lithium-drifted silicon detectors. The first detector will stop electrons in the 50-150 keV range, and protons in the 50 keV-3 MeV range. The second detector will respond to electrons in the interval 150 keV - 1 MeV and protons between 3 MeV and 20 MeV. The third element serves as an anticoincidence guard. A suitable lead shield for radiation from the spacecraft RTG's is used to reduce the background count for the second low-energy telescope. The three telescopes and their associated electronics are contained in a single housing located on the upper shelf of the experiment compartment.

PARAMETER SUMMARY:

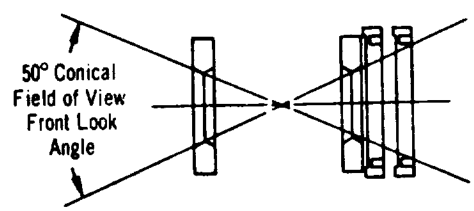
Dimensions:	15.2 x 16.5 x 20.3 cm (6.0 x 6.5 x 8.0 in.)
Weight:	3.1 kg (6.9 lbs)
Power:	2.2 W
Detectors:	Lithium-drifted silicon
High Energy Telescope Range:	Penetrating Particles - 50 to 800 MeV/nucleon Stopping Particles - 22 to 50 MeV/nucleon
Low Energy Telescope Range:	Telescope A - 3 to 22 MeV/nucleon Telescope B First Detector - Electrons - 50 to 150 keV Protons - 50 keV to 3 MeV Second Detector - Electrons - 150 keV to 1 MeV Protons - 3 to 20 MeV

SOURCE:

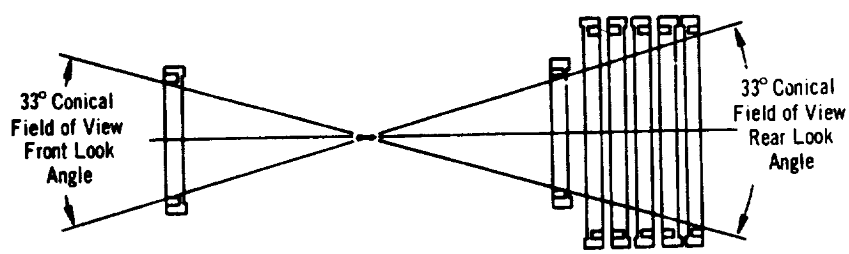
Data:	Pioneer F/G Technical Plan, Pioneer Document P-201.
Reference:	



Low Energy Telescope



Low Energy Telescope



High Energy Telescope

Pioneer 11 Cosmic Ray Telescope

EXPERIMENT CATEGORY:	Magnetic Field
DATE OF LAUNCH:	April, 1973
INSTRUMENT NAME:	Fluxgate Magnetometer
SPACECRAFT:	Pioneer 11
DESTINATION:	Planet Jupiter
PRINCIPAL INVESTIGATOR:	Norman Ness, Goddard Space Flight Center
INSTRUMENT CONTRACTOR:	Goddard Space Flight Center Spacetac Incorporated, Bedford, Massachusetts

PURPOSE: To measure and determine the topology of the strong magnetic field which has been predicted for Jupiter based on radio observations of its magnetosphere.

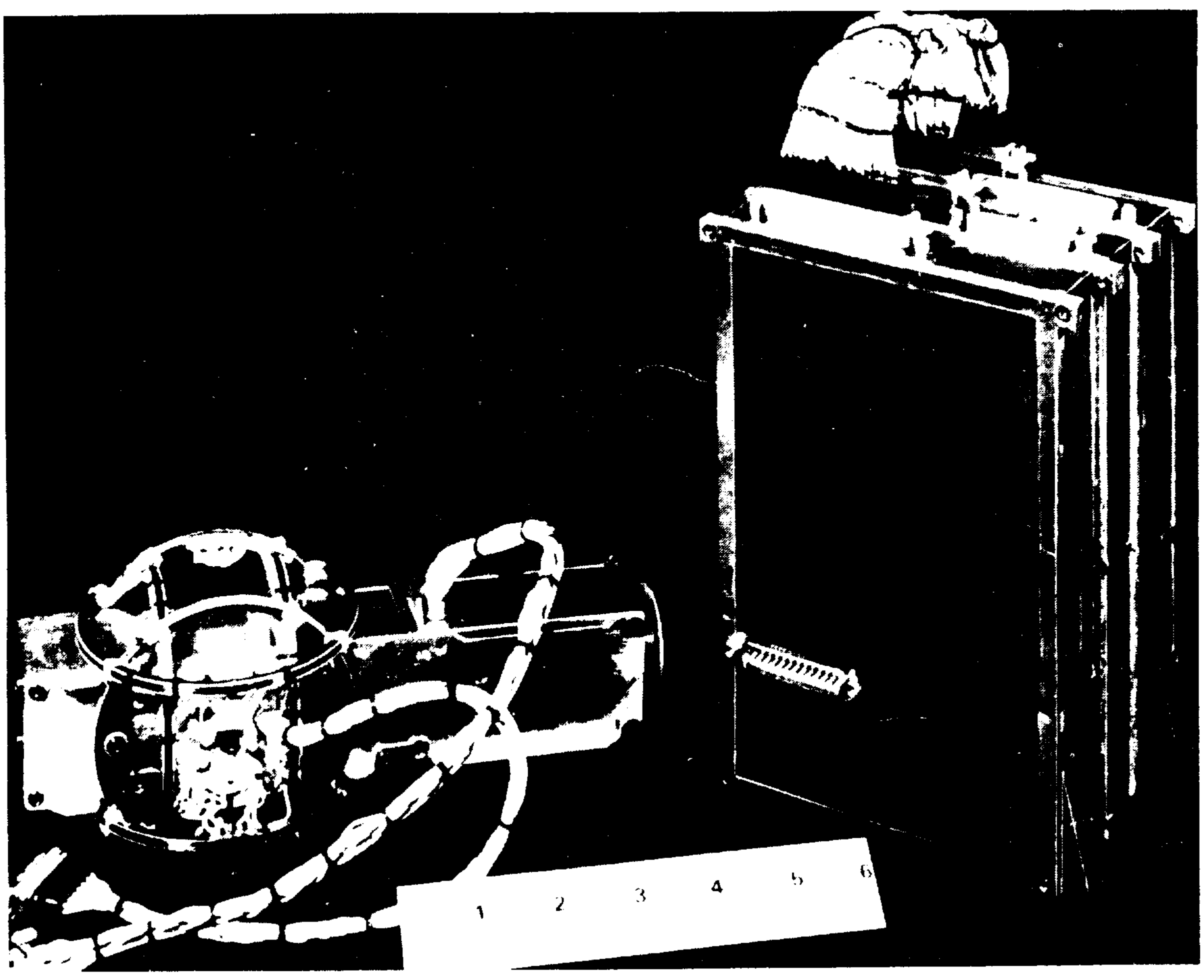
DESCRIPTION: The magnetometer consists of a single package which includes two dual axis sensors and associated electronics for timing and data handling. The package is approximately 4.6 x 7.1 x 10.9 cm (1.8 x 2.8 x 4.3 in.) and weighs approximately 0.3 kg (0.6 lbs). The instrument is located above (toward the high gain antenna) the scientific instrument compartment and in the vicinity of the Cosmic Ray Telescope and Plasma Analyzer. Continuous measurements of the vector magnetic field along the spacecraft trajectory; from about 12.6 Jupiter radii to the radius of closest approach, will be possible with the Fluxgate Magnetometer. Magnetic field strengths of up to 10 gauss for each orthogonal component will be measured, which should be adequate to describe the near Jovian Field. Two sensors are comprised of a ring core, a magnetic multivibrator, a frequency doubler, and two phase sensitive detectors. The ring core of Sensor 1 and the ring core of Sensor 2 are orthogonally mounted and together provide measurements along three orthogonal axes, plus an auxiliar measurement along the Z axis. Each ring core is diametrically wound with two orthogonal sense windings which sense the magnetic field and also function as a frequency control device for the multivibrator. The multivibrators cylically drive the ring cores to saturation at a frequency of approximately 8 kHz. Signals from the sense windings caused by an external magnetic field (hopefully Jupiter's) are applied to the two phase sensitive detectors. Reference signals for the phase detectors are derived from the frequency doubler which differentiates and full wave rectifies the square wave generated by the multivibrator.

PARAMETER SUMMARY:

Dimensions:	4.6 x 7.1 x 10.9 cm (1.8 x 2.8 x 4.3 in.)
Weight:	0.3 kg (0.6 lbs)
Power:	.36 W
Range:	Up to 10 gauss

SOURCE:

Data:	Specification Document, Dr. Norman Ness, principal investigator.
Reference:	



Pioneer 11 Helium Vector Magnetometer

EXPERIMENT CATEGORY:	Magnetic Field
DATE OF LAUNCH:	April, 1973
INSTRUMENT NAME:	Helium Vector Magnetometer
SPACECRAFT:	Pioneer 11
DESTINATION:	Planet Jupiter
PRINCIPAL INVESTIGATOR:	E.J. Smith, Jet Propulsion Lab
INSTRUMENT CONTRACTOR:	Jet Propulsion Lab Time Zero Corporation

PURPOSE: To map the interplanetary magnetic field beyond 2 AU, to study the interaction of the solar wind with Jupiter's magnetosphere, to measure Jupiter's magnetic fields with sufficient precision to determine its source characteristics, to locate and to investigate the solar galactic boundary region.

DESCRIPTION: This instrument for Pioneer 11, an advanced version of those flown on Mariner IV and V, is an extremely stable, low-noise device for near-simultaneous measurement of the three axial components of the ambient magnetic field. It possesses the necessary sensitivity over the wide dynamic range needed to operate in both the very weak interplanetary fields at 5 AU and beyond, and in the strong planetary field of Jupiter, covering this range in eight selectable operating ranges from ± 2.5 gamma to ± 1.43 gauss. The helium vector magnetometer is a helium-filled cell subjected to RF excitation and infrared optical pumping. The gas exhibits variations in optical properties which are, in part, modulated by the ambient magnetic field, and this component of overall response can be extracted and phase detected to provide the desired axial field measurements. The sensor package, containing the helium cell, RF excitation, IR lamp and optics and the magnetic sweep drive components are enclosed in a cylindrical "coil cage" about 12.7 cm (5.0 in.) in diameter and 22.9 cm (9.0 in.) in length, and is mounted at the outboard end of a 6.0 m (20 ft) boom to separate it from spacecraft magnetic contributions. The electronics package, containing the signal processing logic and power circuitry is an 20.3 x 12.7 x 10.2 cm (8.0 x 5.0 x 4.0 in.) box located within the spacecraft equipment compartment. The combined weight of sensor and electronics is 2.0 kg (4.5 lbs). The average power requirement is 3 W and the peak power requirement is 4.1 W during measurement of strong fields.

PARAMETER SUMMARY:

Dimensions:	Coil Cage - 22.9 x 12.7 cm (9.0 x 5.0 in.), Electronics Package - 20.3 x 12.7 x 10.2 cm (8.0 x 5.0 x 4.0 in.) Boom - 6.0 m (20.0 ft).
Weight:	2.0 kg (4.5 lbs)
Power:	3 W average - 4.1 W peak
Range:	± 2.5 gamma to ± 1.43 gauss

SOURCE:

Data:	Pioneer F/G Technical Plan, Pioneer Document P-201.
Reference:	

EXPERIMENT CATEGORY:	Micrometeoroid
DATE OF LAUNCH:	April, 1973
INSTRUMENT NAME:	Asteroid/Meteoroid Detector
SPACECRAFT:	Pioneer 11
DESTINATION:	Planet Jupiter
PRINCIPAL INVESTIGATOR:	R.K. Soberman, G.E. Company
INSTRUMENT CONTRACTOR:	General Electric Company

PURPOSE: To attempt to detect and measure parameters of asteroids and meteoroids as small as 1×10^{-6} grams mass, in the asteroid belt and interplanetary space, by optical sensing. Its objectives are to assess solid particle flux, mass properties, spectra, and velocities, and to contribute a basis for determining particulate origin and spatial distribution.

DESCRIPTION: This instrument consists of an array of four, independent, non-imaging, optical telescopes which detect asteroids and meteoroids by their reflected or scattered solar light. Each telescope consists of an 20.3 cm (8.0 in.) diameter, concave, hyperbolic, primary mirror 8.4 cm (3.3 in.) diameter, convex, hyperbolic, secondary mirror, suitable coupling optics and a 3.0 cm (1.2 in.) diameter photomultiplier tube. Each telescope forms a 10° view cone, the four view cones overlapping in part, to form regions of 2, 3 and 4-way coincidence. Photomultiplier output pulses are counted to determine flux. The particle range and velocity components are measured by timing entry and exit of reflections in the view cones. The instrument achieves a 0.2 radian instantaneous field of view (IFOV) and an overall resolution of 0.1 milliradians. A star-exclusion circuit serves to exclude "fixed" background except during in-flight calibrations and sky mapping. The instrument's 4 telescopes and their associated preamplifiers and power supplies are mounted on a special adapter panel outside the spacecraft equipment compartment to provide the needed view angles and freedom from scatter or reflection from spacecraft structure. The balance of the signal processing, logic, power, control and interface circuitry is contained in a 15.2 x 15.2 x 5.1 cm (6.0 x 6.0 x 2.0 in.) housing located within the equipment compartment.

PARAMETER SUMMARY:

Dimensions:	15.2 x 15.2 x 5.1 cm (6.0 x 6.0 x 2.0 in.)
Weight:	2.3 kg (5.1 lbs)
Power:	2 W
IFOV:	0.2 rad
Overall Resolution:	0.1 mrad

SOURCE:

Data:	Pioneer F/G Technical Plan, Pioneer Document P-201.
Reference:	

EXPERIMENT CATEGORY:	Micrometeoroid
DATE OF LAUNCH:	April, 1973
INSTRUMENT NAME:	Meteoroid Detector
SPACECRAFT:	Pioneer 11
DESTINATION:	Planet Jupiter
PRINCIPAL INVESTIGATOR:	W.H. Kinard, NASA/LRC
INSTRUMENT CONTRACTOR:	Langley Research Center

PURPOSE: To gain insight into flux levels, distribution and particulate size of meteoroids too small to detect readily by optical means, and to perform a preliminary study of the meteoroid penetration hazard to future spacecraft traversing the asteroid belt.

DESCRIPTION: This instrument consists of 12 banks of penetration cells, attached on standoffs to the spacecraft's exterior. Each bank is approximately 20.3 x 30.5 cm (8.0 x 12.0 in.) in size, constructed like an air mattress, with 18 individual cells in each bank. Each cell contains a pressure-sensitive transducer and is filled with neon prior to sealing. Penetration by a particle, in the mass range under study, causes a gradual pressure loss, with evacuation time ranging from a few seconds to as long as 30 minutes in duration. The transducer detects this pressure loss as a critical pressure is reached and a plasma discharge takes place across the cell. These events are counted to indicate meteoroid population and cell discharge timed to give an indication of penetration hole size and thus particle size and incident energy. The signal processing, logic, power and interface circuitry are contained in a housing 7.6 x 7.6 x 7.6 cm (3.0 x 3.0 x 3.0 in.), located in the spacecraft equipment compartment. Total weight of cell banks and electronics and interconnecting cabling is 1.8 kg (3.9 lbs). Average power required is 1 W.

PARAMETER SUMMARY:

Dimensions:	7.6 x 7.6 x 7.6 cm (3.0 x 3.0 x 3.0 in.)
Weight:	1.8 kg (3.9 lbs)

Power:	1 W

SOURCE:

Data:	Pioneer F/G Technical Plan, Pioneer Document P-201.
Reference:	

EXPERIMENT CATEGORY:	Plasma
DATE OF LAUNCH:	April, 1973
INSTRUMENT NAME:	Plasma Analyzer
SPACECRAFT:	Pioneer 11
DESTINATION:	Planet Jupiter
PRINCIPAL INVESTIGATOR:	J.H. Wolfe, ARC
INSTRUMENT CONTRACTOR:	Ames Research Center Time Zero Corporation

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PURPOSE: To measure spatial and temporal characteristics of the solar plasma as functions of heliocentric radial distance, to determine composition, energy distribution, ion and electron flux and energy spectra, to investigate the interaction of the solar wind with Jupiter's magnetosphere, and to search for and examine the solar/galactic boundary region.

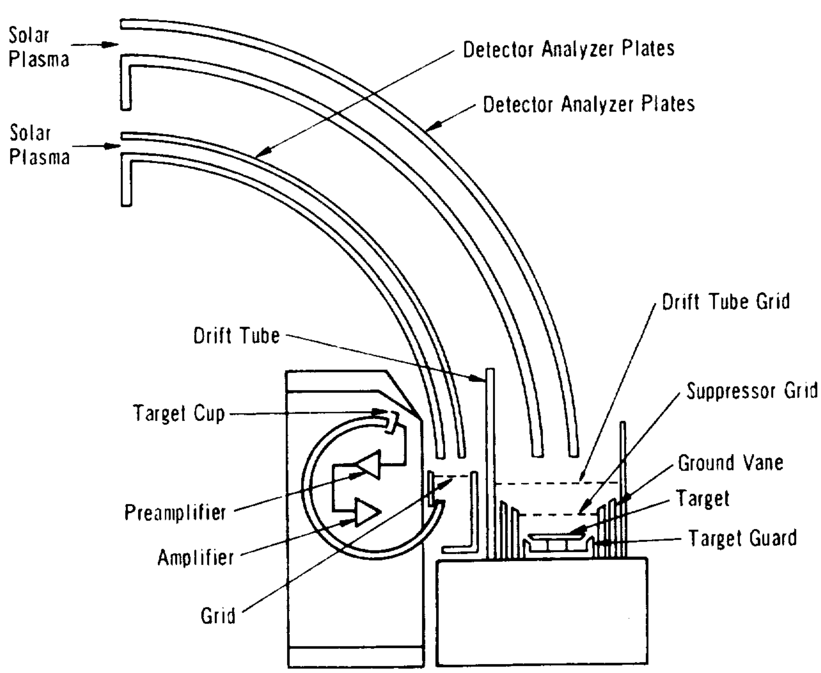
DESCRIPTION: This instrument consists of two concentric quadrispherical electrostatic plasma analyzers which measure ions and electrons as to direction of travel, energy and flux levels. Detector A consists of a pair of 90° quadrispherical plates with mean radius of 9 cm and plate separation of 0.5 cm. At the exit aperture a bank of 26 continuous-channel-multipliers, serving as "targets", is arranged to provide direction and energy measurements of incoming flux. Detector B consists of a similar pair of quadrispherical plates with mean radius of 12 cm and separation of 1.0 cm. A bank of 5 targets, each monitored by an elecrrometer amplifier, provides directional and energy measurement. The use of two curved plate detectors provides the necessary resolution over the wide range of particle energies, densities and incidence angles expected due to spacecraft orientation, view angle restrictions and non-thermal distributions caused by local particle acceleration. Detector A covers an ion energy range from 100 to 8,000 electron volts, in 16, 32 or 64 energy steps, depending on ground-commandable operating mode. Detector B covers an ion energy range from 100 to 8,000 eV, and an eV range from 1 to 500 eV in 32 or 64 steps and 16 steps, respectively.

PARAMETER SUMMARY:

Dimensions:	29.2 x 27.9 x 15.2 cm (11.5 x 11.0 x 6.0 in.)
Weight:	5.0 kg (11.0 lbs)
Power:	4.4 W
Field of View:	20° by 140° solar direction
Detectors:	Detector A - Pair of 90° quadrispherical plates, 9 cm mean rad., 0.5 cm plate separation Detector B - Pair of 90° quadrispherical plates, 12 cm mean rad., 1.0 cm plate separation
Range:	Detector A - 100 to 8,000 eV for ions in 16, 32 or 64 energy steps Detector B - 100 to 8,000 eV for ions in 32 or 64 steps 1 to 500 eV for electrons in 16 steps

SOURCE:

Data:	Pioneer F/G Technical Plan, Pioneer Document P-201.
Reference:	Time-Zero Corporation, Pioneer F and G ARC Plasma Analyzer: Detailed Instrument Description, 1 September 1970, Contract NAS2-5611.



Pioneer 11 Plasma Analyzer

EXPERIMENT CATEGORY:	Ultraviolet Photometry
DATE OF LAUNCH:	April, 1973
INSTRUMENT NAME:	Ultraviolet Photometer
SPACECRAFT:	Pioneer 11
DESTINATION:	Planet Jupiter
PRINCIPAL INVESTIGATOR:	D.L. Judge, U.S.C.
INSTRUMENT CONTRACTOR:	University of Southern California Analog Technology Corporation

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PURPOSE: To determine the interplanetary neutral hydrogen density by observing its interaction with the solar wind over large solar distances by means of photometric measurements in the extreme ultraviolet range, to determine the radius of the heliosphere, the distance to the solar wind transition region, from precise measurements of the hydrogen distribution to 5 AU and beyond, to measure the H_2He ratio in the Jupiter atmosphere, to determine the temperature of the Jovian upper atmosphere, and to locate the Jovian day-side auroral "oval" by a UV photometric survey at encounter.

DESCRIPTION: This instrument is a single channel ultraviolet photometer operating in the 200 to 800 Å range. Rejection of shorter and longer wavelengths is achieved with use of a thin aluminum mesh filter. The incident light is sensed by a lithium fluoride target cathode, 3.8 cm (1.5 in.) in diameter, which transmits an electron stream proportional to light intensity to a channeltron detector-amplifier. The sensor and all associated electronics are contained in a housing approximately 10.2 x 10.2 x 12.7 cm (4.0 x 4.0 x 5.0 in.) with a 7.6 cm (3.0 in.) diameter sensor tube protruding from the housing and through the spacecraft equipment platform approximately 10.2 cm (4.0 in.). Total weight of the unit is 0.7 kg (1.5 lbs). Power requirement is 1 W, continuous.

PARAMETER SUMMARY:

Dimensions:	10.2 x 10.2 x 12.7 cm (4.0 x 4.0 x 5.0 in.)
Weight:	0.7 kg (1.5 lbs)

Power:	1 W
Detector:	Channeltron
SOURCE:	
Data:	Pioneer F/G Technical Plan, Pioneer Document P-201.
Reference:	

EXPERIMENT CATEGORY:	Visible Frequency, Telescopes
DATE OF LAUNCH:	April, 1973
INSTRUMENT NAME:	Imaging Photopolarimeter
SPACECRAFT:	Pioneer 11
DESTINATION:	Planet Jupiter
PRINCIPAL INVESTIGATOR:	T. Gehrels, University of Arizona
INSTRUMENT CONTRACTOR:	University of Arizona Santa Barbara Research Center Dudley Observatory

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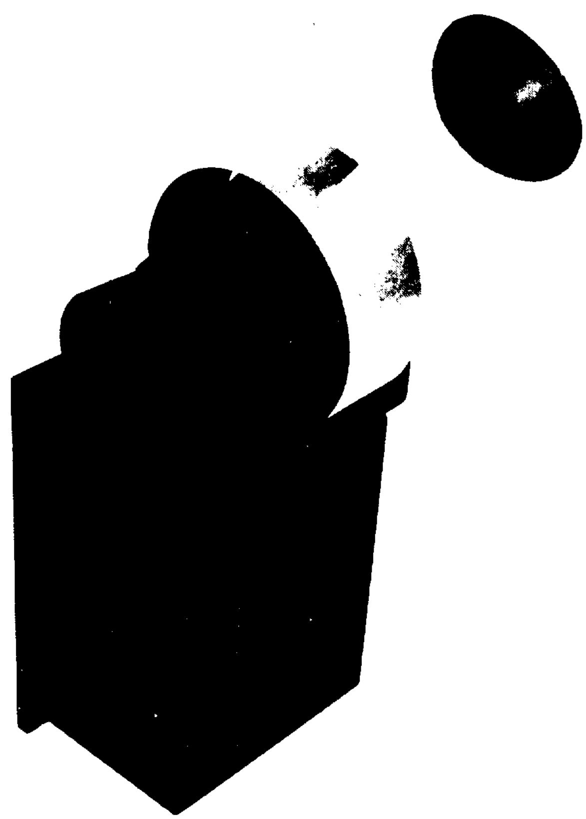
PURPOSE: To perform zodiacal light mapping during the flight, to measure brightness and polarity of light over a wide range of scattering angles, to take photopolarization measurements of asteroids and solid particulate matter in the asteroid belt, and to perform two-color, visible-light imaging of Jupiter by spin-scan techniques during encounter.

DESCRIPTION: This instrument consists of an optical telescope positioned by a spin-scan stepping motor, a beamsplitting optical prism, two sets of coupling and filtering optics, channeltron detectors, and signal processing, logic, control, interface, and power circuitry. The telescope, which protrudes from the side of the spacecraft equipment compartment, provides an image with instantaneous field of view (IFOV) of 32 x 40 mrad for zodiacal light studies, 8 x 8 or 12 x 12 mrad (selectable by ground command) for photopolarimetry and 0.5 x 0.5 mrad for imaging. A Wallastron prism splits the image into two orthogonally polarized beams which are filtered to two-color channels; 3900 to 4900 Å (Blue) and 5800 to 7000 Å (Red). The spin-scan mechanism provides 0.5 milliradian scan angle stepping increments by ground command. Output from the channeltron detectors is processed and stored during the brief scan period for readout at spacecraft telemetry rates between scan periods.

PARAMETER SUMMARY:

Dimensions:	17.8 x 19.0 x 25.4 cm (7.0 x 7.5 x 10.0 in.)
Weight:	4.1 kg (9.0 lbs)

Power:	3.5 W average, 4.1 W peak
Telescope:	2.5 cm (1.0 in.) aperture, 8.6 cm (3.4 in.) focal length, Maksutov-type
IFOV:	32 x 40 mrad for zodiacal light, 8 x 8 or 12 x 12 mrad for photopolarimetry, and 0.5 to 0.5 mrad for imaging
Filters:	Blue (3900 to 4900 Å) and Red (5800 to 7000 Å)
Detectors:	Channeltron
Resolution:	200 km
SOURCE:	
Data:	Pioneer F/G Technical Plan, Pioneer Document P-201.
Reference:	



Pioneer 11 Imaging Photopolarimeter

EXPERIMENT CATEGORY: Atmospheric Structure

DATE OF LAUNCH: July, 1973

INSTRUMENT NAME: Vertical Temperature Profile Radiometer (VTPR)

SPACECRAFT: ITOS-E

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: N. Ness, NOAA-Ness, Suitland, Maryland

INSTRUMENT CONTRACTOR:

PURPOSE: To measure emitted energy in the 15-micron carbon dioxide band permitting the determination of the vertical temperature profile over the Earth's surface at least twice a day.

DESCRIPTION: The experiment consists of two sensors, one sensitive to energy in the 11-micron region and the other sensitive to water vapor in the 19-micron region, which are used in conjunction with six carbon dioxide sensors and provide indication of cloud cover and the contribution of water vapor to received energy. Since daylight radiance measurements in the 15 to 19-micron region have the same accuracy as those made at night, the measurements may be made continuously. Data are recorded throughout the orbit on the scanning radiometer recorder and played back on command when the spacecraft is over a CDA station. Ground personnel employ the data to make computer calculations of the temperature profile to an altitude of 30,480 meters (100,000 ft).

PARAMETER SUMMARY:

Dimensions: 43.9 x 27.4 x 17.3 cm (17.3 x 10.8 x 6.8 in.)

Weight: 13.6 kg (30.0 lbs)

Power: 19 W (average)

Resolution: Angular - 2° 38' x 2° 44'
Ground - 66.6 x 70.3 km

Spectral Regions:	8 15 micron CO_2 - 6 Window - 1 Water Vapor - 1
Sensitivity:	Q Branch - 0.5 ergs/sec cm^2 SR cm^{-1} Other Channels - 0.25 ergs/sec cm^2 SR cm^{-1}
Dynamic Range:	0 to 220 ergs/sec cm^2 SR cm^{-1}
Detector:	Pyroelectric
Data Rate:	512 bits/sec (digital)
Scan Rate:	1 per 12.5 sec
SOURCE:	
Data:	Harold Oseroff, ITOS Project Coordinator, Goddard Space Flight Center
Reference:	Same as above.

EXPERIMENT CATEGORY: Plasma

DATE OF LAUNCH: July, 1973

INSTRUMENT NAME: Solar Proton Monitor

SPACECRAFT: ITOS-E

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: C.O. Bostrom, Applied Physics Lab, Silver Spring, Md.

INSTRUMENT CONTRACTOR:

PURPOSE: To monitor the omnidirectional fluxes of solar protons with energies above 10, 30 and 60 MeV respectively. To measure fluxes of protons and alpha particles.

DESTINATION: Three solid state detectors are included and telescopes consisting of solid state detectors, which each measure directional fluxes of protons in three energy intervals between 0.27 and 3.2 MeV, protons between 3.2 and 60 MeV, protons above 60 MeV, and alpha particles between 12.5 and 32 MeV. In the polar cap region which is of the greatest interest, the telescopes view parallel to, and perpendicular to, the local magnetic field direction. An additional solid state detector measures directional fluxes of electrons of energies greater than 140 keV. This detector looks in a direction perpendicular to the orbit plane.

PARAMETER SUMMARY:

Dimensions:

Weight:

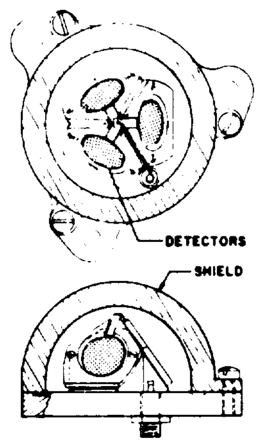
Power:

Range: Solar Protons - above 10, 30 and 60 MeV
Protons between - 0.27 and 3.2 MeV, 3.2 and 60 MeV
Protons above - 60 MeV
Alpha particles between - 12.5 and 32 MeV
Electrons greater than - 140 keV

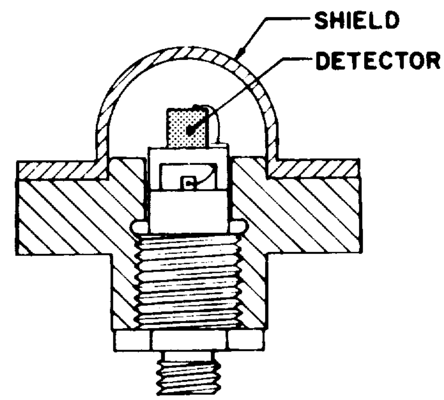
SOURCE:

Data: NSSDC AIM Printout (2 October 1972), ID No. ITOS-E-01.

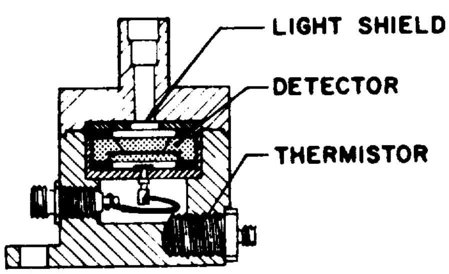
Reference:



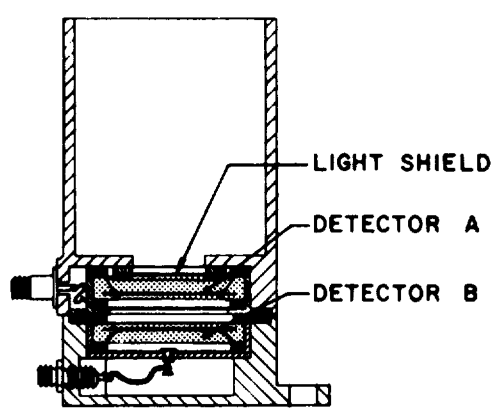
(a) Proton Sensors 1 and 2



(b) Proton Sensor 3



(c) Electron Sensor 4



(d) Dual Channel Proton Sensors 5 and 6

ITOS-E Solar Proton Monitor

EXPERIMENT CATEGORY:	Visible and Infrared Radiometry
DATE OF LAUNCH:	July, 1973
INSTRUMENT NAME:	Scanning Radiometer Subsystem
SPACECRAFT:	ITOS-E
DESTINATION:	Earth Orbit
PRINCIPAL INVESTIGATOR:	N. Ness, NOAA-Ness, Suitland, Maryland
INSTRUMENT CONTRACTOR:	

PURPOSE: To measure infrared radiation emitted from the Earth during orbit day and night, and reflected visual radiation from the Earth during orbit day.

DESCRIPTION: The scanning radiometer subsystem is a redundant radiometer and tape recorder combination. It consists of two scanning radiometers, a dual scanning radiometer processor, and two scanning radiometer recorders. The scanning radiometer forms an image using a continuously rotating mirror. The mirror scans the Earth's surface perpendicular to the satellite's orbital path at a rate of 48 rpm. As the satellite progresses along its orbital path, each rotation of the mirror is passed through a beam splitter and spectral filter to produce the desired spectral separation. The data are transmitted in real time to local APT stations, and also recorded on board the spacecraft for later playback to the CDA stations. The radiometer detects reflected visible energy from the Earth in the 0.52-0.73-micron region, and infrared radiation emitted from the Earth in the 10.5 - 12.5-micron region. From these measurements, the temperature of the emitting surface (ground, water, or cloud tops) are determined. The 10.5 to 12.5 micron region permits the temperature to be determined during both day and night, since the reflected solar radiation in this wavelength is small compared with the emitted radiation.

PARAMETER SUMMARY:

Dimensions: 16.3 x 40.6 x 256.0 cm (6.4 x 16.0 x 100.8 in.)

Weight: 9.1 kg (20.0 lbs)

Power:	14 W (average)
Angular Resolution:	Visible Channel - 2.8 milliradians Infrared Channel - 5.3 milliradians
Ground Resolution:	Visible Channel - 3.7 km Infrared Channel - 7.4 km
Spectral Region:	Visible Channel - 0.52 to 0.73 microns Infrared Channel - 10.5 to 12.5 microns
Sensitivity:	(Noise Equivalent Differential Temperature) Infrared Channel - @ 185° K - 4° K - @ 300° K - 1° K
Dynamic Range:	Visible Channel - 65 to 10,000 ft-lamberts (scene brightness) Infrared Channel - 180° K to 330° K (scene temperature)
Detector:	Visible Channel - Silicon Photovoltaic Infrared Channel - Thermistor bolometer
Electrical Bandwidth:	Visible Channel - 1,200 Hz (analog) Infrared Channel - 600 Hz (analog)
Scan Rate:	Visible Channel - 48 rpm Infrared Channel - 48 rpm

SOURCE:

Data:	Harold Oseroff, ITOS Project Coordinator, Goddard Space Flight Center. NSSDC AIM Printout (2 October 1972), ID No. ITOS-E-02.
Reference:	Harold Oseroff, ITOS Project Coordinator, Goddard Space Flight Center.

EXPERIMENT CATEGORY:	Visible and Infrared Radiometry
DATE OF LAUNCH:	July, 1973
INSTRUMENT NAME:	Very High Resolution Radiometer (VHRR)
SPACECRAFT:	ITOS-E
DESTINATION:	Earth Orbit
PRINCIPAL INVESTIGATOR:	
INSTRUMENT CONTRACTOR:	

PURPOSE: To continuously (during both the day and the night portions of the orbit) measure surface-emitted energy from which temperatures of the earth, sea and cloud tops are deduced.

DESCRIPTION: This experiment is a two-channel device which detects reflected visual radiation from the Earth. One channel detects reflected visible energy from the cloud tops in the spectral range of 0.6 to 0.7 microns once a day. The second channel detects infrared radiation emitted from the earth, sea and cloud tops in the 10.5 to 12.5 micron range. The spacecraft transmits data in real time to VHRR stations throughout the world for use in local weather analysis. In addition to real time data transmission, approximately 9 minutes of data are recorded for later playback while over a CDA station. The area for obtaining the recorded data may be selected anywhere throughout the orbit.

PARAMETER SUMMARY:

Dimensions:	31.9 x 48.0 x 26.4 cm (12.2 x 18.9 x 10.4 in.)
Weight:	9.5 kg (21.0 lbs)
Power:	7 W (average)
Resolution:	Angular - 0.6 milliradians for visible channel - 0.6 milliradians for infrared channel Ground - 0.9 km for visible channel - 0.9 km for infrared channel

Spectral Region:	Visible Channel - 0.6 to 0.7 microns Infrared Channel - 10.5 to 12.5 microns
Sensitivity:	(Noise Equivalent Differential Temperature) Infrared Channel - @ 185° K - 3° K @ 300° K - 1° K
Dynamic Range:	Visible Channel - 65 to 10,000 ft-lambert (scene brightness) Infrared Channel - 180° K to 315° K (scene temperature)
Detector:	Visible Channel - Silicon Photovoltaic Infrared Channel - Mercury-Cadmium Telluride
Electrical Bandwidth:	Visible Channel - 35 kHz (analog) Infrared Channel - 35 kHz (analog)
Scan Rate:	400 rpm for both channels

SOURCE:

Data:	Harold Oseroff, ITOS Project Coordinator, Goddard Space Flight Center.
Reference:	Same as above.

EXPERIMENT CATEGORY: Plasma

DATE OF LAUNCH: September, 1973

INSTRUMENT NAME: Impedance Probe

SPACECRAFT: RAE-B

DESTINATION: Lunar Orbit

PRINCIPAL INVESTIGATOR: R.G. Stone, Goddard Space Flight Center

INSTRUMENT CONTRACTOR: Goddard Space Flight Center

PURPOSE: To measure, with directivity, the intensity of radio signals from celestial sources as a function of frequency, direction, and time. To provide mapping of the galaxy completely free from perturbing effects of the terrestial ionosphere.

DESCRIPTION: The antenna and spacecraft function as two capacitor plates with the ambient plasma acting as the dielectric. Frequency shifts in two coupled oscillators connected to the antenna indicate changes in antenna capacitance. Electron density can be determined from these frequency shifts. After receipt of a frequency select signal from the spacecraft programmer, the frequency synthesizer generates two frequencies; the selected test frequency, which is applied to the antenna for impedance measurement, and a second frequency which is the local oscillator frequency. This second frequency is used to mix with the test frequency to produce an IF product for measurement. The test frequency is applied to the antenna terminals. The test current fed into the antenna leads and the voltage across the terminals are sensed by two separate gain stabilized amplifiers and mixed with the second signal from the frequency synthesizer. The IF product of each channel (500 Hz) is then amplified and peak detected to give the value of voltage and current as a DC voltage. The phase relationship between the voltage and current is also found and converted to an output voltage. The three voltages representing antenna current, voltage, and the phase between antenna current and voltage are applied to an expander circuit. This 10 to 1 expander gives a coarse measurement which is accurate to 1 part in 16 and a fine measurement that is referenced to one of the 16 parts of the coarse measurement. Thus, the expander provides a greater resolution than a single telemetry word allows by dividing the readings into two words. Care has been taken in the design to limit the sources of error in the readings. All gain stages are temperature and age stabilized through the use of feedback networks. All components have been derated to improve the reliability and guard against failure due to radiation and aging. This experiment makes use of the spacecraft antenna subsystem (short dipole and V antennas) to collect the data.

PARAMETER SUMMARY:

Dimensions:	12.7 x 17.8 x 3.2 cm (5.0 x 7.0 x 1.2 in.)
Weight:	0.82 kg (1.8 lbs)
Power:	0.1 W
Range:	50 to 1500 ohms with phase from -90° to + 90°
Frequencies:	.2455 MHz, .41 MHz, .491 MHz, .82 MHz, .982 MHz, 1.965 MHz, 3.93 MHz, 6.56 MHz, and 7.86 MHz

SOURCE:

Data:

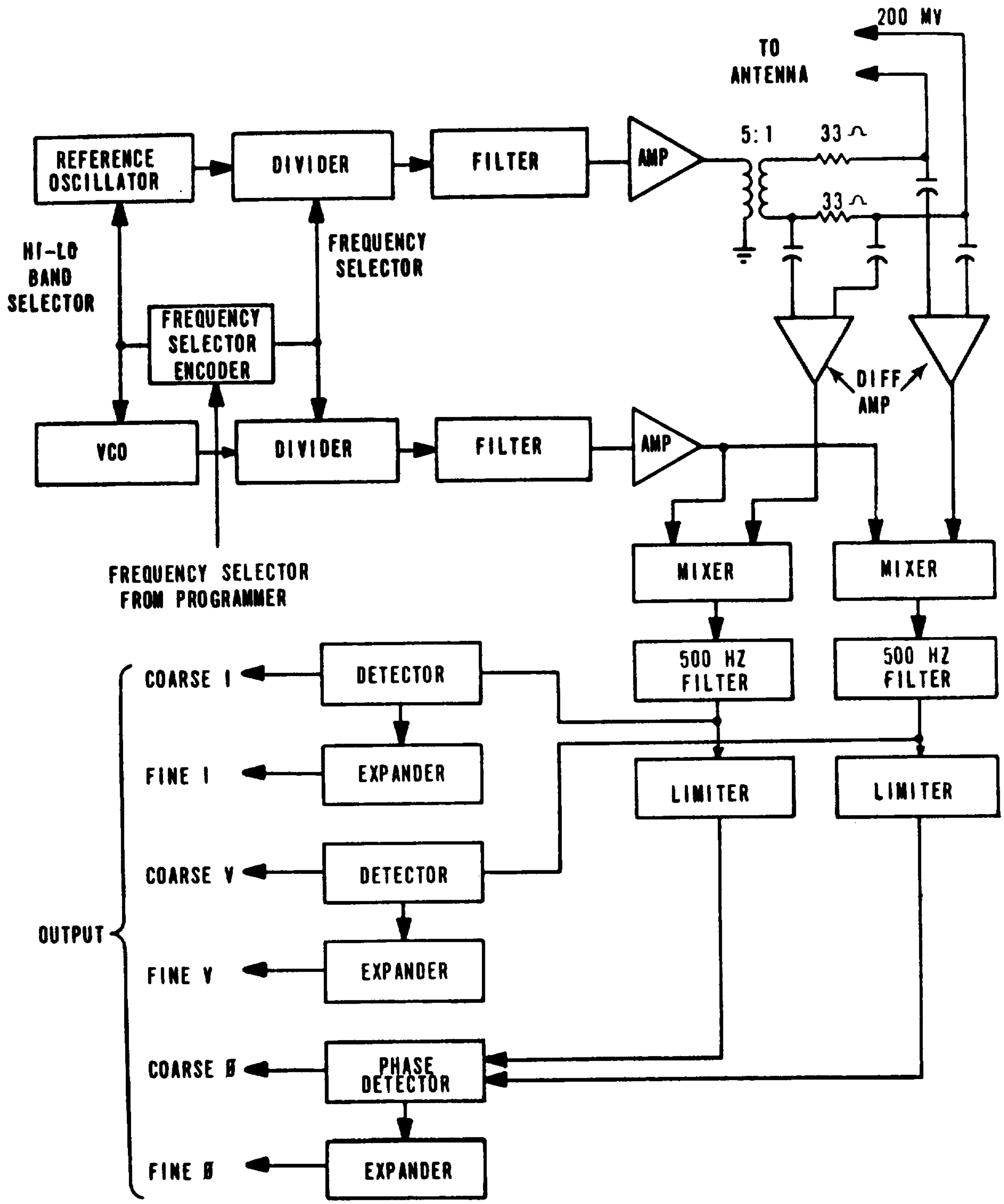
Goddard Space Flight Center, Project Plan for Radio Astronomy Explorer, Lunar Mission (RAE-B) (Phase D), 28 June 1971.

NSSDC AIM Printout (2 October 1972), ID No. RAE-B-03.

Sanders Associates, Inc., Final Report RAE Impedance Probe, 16 January 1970, Contract NAS-5-9342.

Reference:

Dr. R.G. Stone, Goddard Space Flight Center.



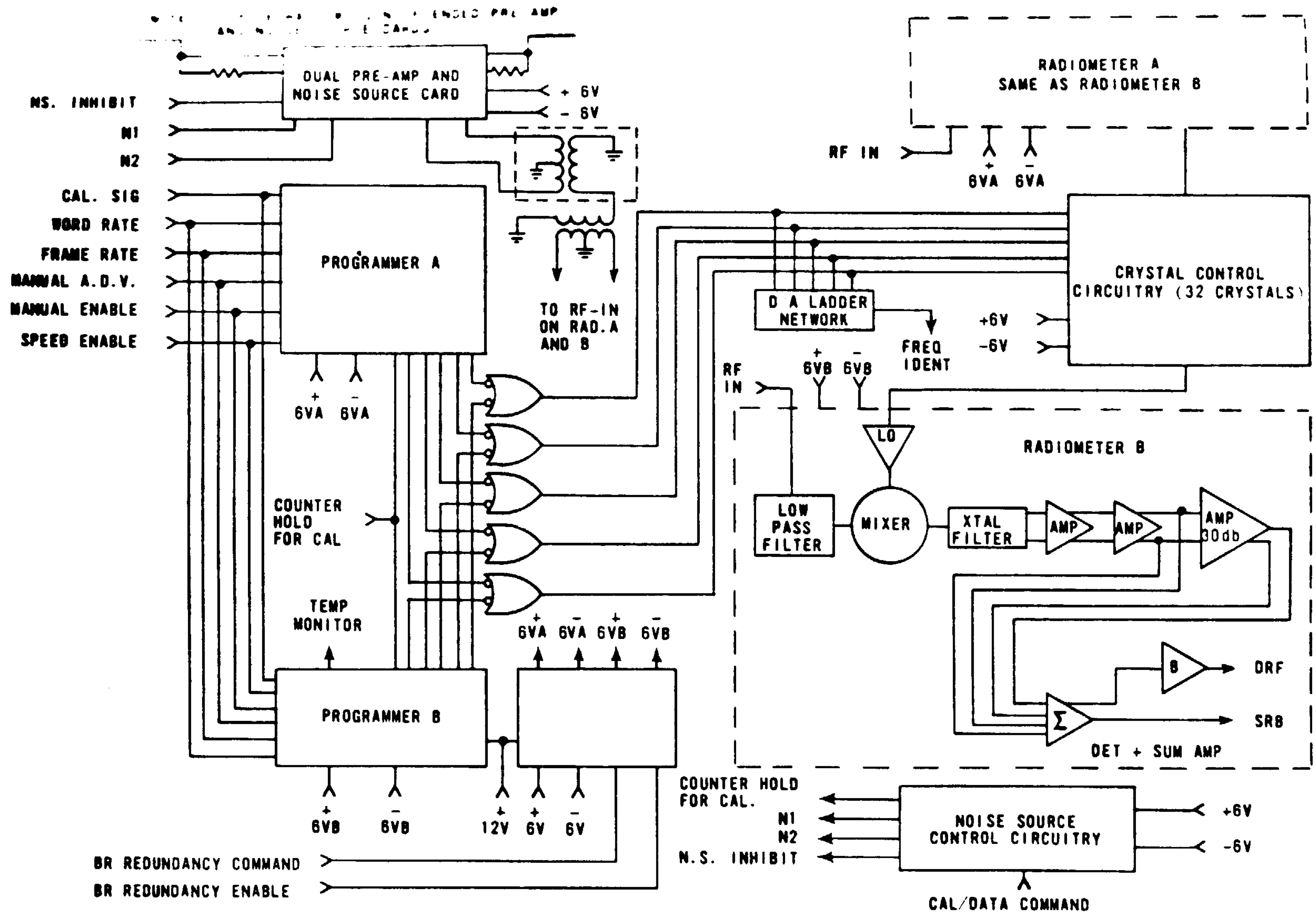
RAE-B Impedance Probe Block Diagram

EXPERIMENT CATEGORY:	Radio Frequency Propagation
DATE OF LAUNCH:	September, 1973
INSTRUMENT NAME:	Rapid-Burst Receivers (Burst Radiometer)
SPACECRAFT:	RAE-B
DESTINATION:	Lunar Orbit
PRINCIPAL INVESTIGATOR:	R.G. Stone, Goddard Space Flight Center
INSTRUMENT CONTRACTOR:	Goddard Space Flight Center

PURPOSE: To measure the characteristics of solar bursts and other rapidly varying noise phenomena. To measure the amplitude of the burst level, the rate of change of frequency of the burst, and the decay time at a particular burst frequency.

DESCRIPTION: Three burst receivers are included. Operating in two sensitivity modes, these receivers can measure signals up to 60 db above the cosmic background level. The 32 channels are cycled every 1.28 seconds. The preamplifiers consist of balanced input stages followed by an emitter follower. The emitter follower feeds a differential amplifier whose output is matched to a 50 ohm transformer at the dual radiometer input. This technique permits the response of the system to be relatively independent of the coaxial line length between the preamplifier and radiometer. Each pair of matched preamplifiers is closely matched over the frequency range of 25 kHz to 10 MHz. Also contained on the preamplifier and noise source card is an internal noise source for system calibration. A Solitron noise diode is used to generate bipolar noise over selected frequency range. This noise diode output is then amplified. The output level is changed by an electronic attenuator which switches in series attenuators between the noise diodes and output amplifier. This amplifier provides a balanced output which may be applied directly to the input of the preamplifiers. Four attenuation steps are provided above the cosmic noise level. Therefore, two noise level calibration points are provided on each slope of the detector curve. That is, two calibration points on the 0 to 30 db range. Radiometer A is stepped through its frequency range in synchronization with the telemetry. Only one radiometer is powered at a time. Switching from one radiometer to the other is performed by a ground command. This experiment makes use of the spacecraft antenna subsystem (short dipole and V antennas) to collect the data.

PARAMETER SUMMARY:	
Dimensions:	
Weight:	6.8 kg (15.0 lbs)
Power:	4.41 W
Dynamic Range:	60 db
Post Detection Time Constant:	10 milliseconds for radiometers one and two 1 millisecond for radiometer three
Local Oscillators:	Crystal controlled with 50 ohm output impedance
Decodes:	Five bit B.C.D. input to select one of the 32 crystal controlled frequencies
SOURCE:	
Data:	Goddard Space Flight Center, Project Plan for Radio Astronomy Explorer, Lunar Mission (RAE-B) (Phase D), 28 June 1971. NSSDC AIM Printout (2 October 1972), ID No. RAE-B-02.
Reference:	Dr. R.G. Stone, Goddard Space Flight Center



RAE-B Rapid Burst Receivers

EXPERIMENT CATEGORY:	Radio Frequency Propagation
DATE OF LAUNCH:	September, 1973
INSTRUMENT NAME:	Step Frequency Radiometers
SPACECRAFT:	RAE-B
DESTINATION:	Lunar Orbit
PRINCIPAL INVESTIGATOR:	R.G. Stone, Goddard Space Flight Center
INSTRUMENT CONTRACTOR:	Goddard Space Flight Center

PURPOSE: To measure, with directivity, the intensity of radio signals from celestial sources as a function of frequency, direction and time. To provide mapping of the galaxy completely free from perturbing effects of the terrestial ionosphere.

DESCRIPTION: Two nine-channel step frequency Ryle Vonberg radiometers are each connected to a 225-meter (750-ft), acute angle V antenna. Antenna noise is measured by constant comparison with an internal voltage-controlled, calibrated noise source adjusted by a servo loop to equal in magnitude the unknown antenna signal. This unit measures by nulling and is very insensitive to internal changes in system gain or bandwidth. This technique places the entire burden of calibration on the internal voltage-controlled noise source. A stable thermistor-bridge power meter is added to continuously measure the output power from the internal noise source thus modifying the standard Ryle Vonberg Subsystem and enhancing the measurement accuracy above the desired limit introducing some redundancy in this area. The desired antenna noise measurement can now be made in two ways - telemetering of the noise - source control voltage (coarse), and telemetering the output of the thermistor-bridge (fine). These two outputs provide redundant information, except that the bridge measurement is inherently more stable and precise. Out of the many ways to make measurement over a wide frequency range, a superheterodyne receiver was chosen. It incorporates separately tuned RF amplifiers and local oscillators for each desired frequency. These individual "front-ends" are tuned on and off in sequence. Since the wide range of input frequencies makes the elimination of images difficult and since this device is intended to measure wide band noise, the image is accepted as part of the measured signal. To facilitate calibration of image and main response, their frequencies are brought close together through use of a very low frequency IF. As the dynamic range of the thermistor-bridge is limited to about 20 db, a switchable attenuator is provided between the noise-source output and the Dicke-switch input at the receiver front end. With associated logic circuits, this attenuator automatically changes ranges to provide a total dynamic range of 60 db. This experiment makes use of the spacecraft antenna subsystem (short dipole and V antennas) to collect the data.

PARAMETER SUMMARY:

Dimensions:	
Weight:	3.36 kg (7.39 lbs)
Power:	1.99 W
Range:	25 kHz to 13.1 MHz
Total Dynamic Range:	60 db
Dynamic Range:	(Thermistor-Bridge) 20 db
Sweeping Range:	25 kHz to 13.1 MHz
Time Constant:	6 milliseconds
Bandpass:	20 kHz in (A) 10 kHz in 3-B
Stepping Channels:	32
Temperature Range:	- 20° C to + 75° C

SOURCE:

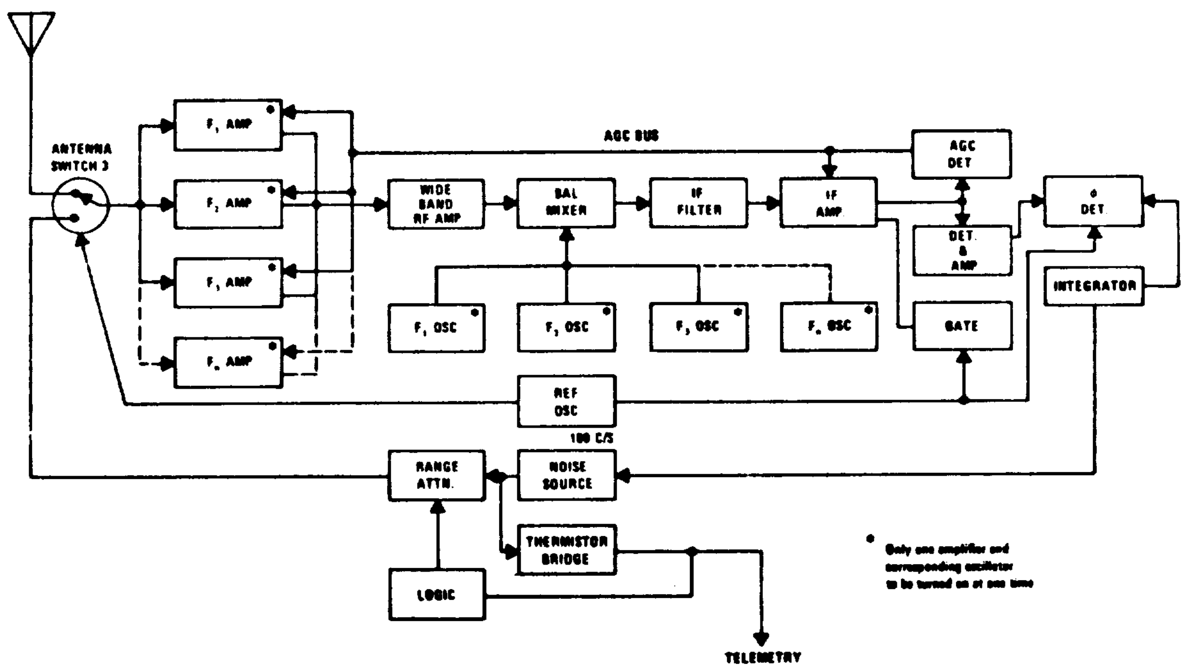
Data:

Goddard Space Flight Center, Project Plan for Radio Astronomy Explorer, Lunar Mission (RAE-B) Phase D, 28 June 1971.

NSSDC AIM Printout (2 October 1972), ID No. RAE-B-01.

Sanders Associates, Inc., Final Report RAE-B Dual Swept Frequency Radiometer System, November, 1971, Contract NAS-5-11307.

Reference: Dr. R.G. Stone, Goddard Space Flight Center.



RAE-B Step - Frequency Radiometer Block Diagram

EXPERIMENT CATEGORY: Atmospheric Composition

DATE OF LAUNCH: October, 1973

INSTRUMENT NAME: Ultraviolet Spectrometer

SPACECRAFT: Mariner J (MVM'73)

DESTINATION: Venus/Mercury

PRINCIPAL INVESTIGATOR: A.L. Broadfoot, Kitt Peak National Observatory

INSTRUMENT CONTRACTOR:

PURPOSE: To detect the presence of an atmosphere on Mercury and determine its structure and composition; to observe and determine the structure and composition of the Venusian atmosphere; to map the diffuse galactic and interplanetary background radiation; and to observe the Earth Geocorona, especially at 584 and 1216 Å.

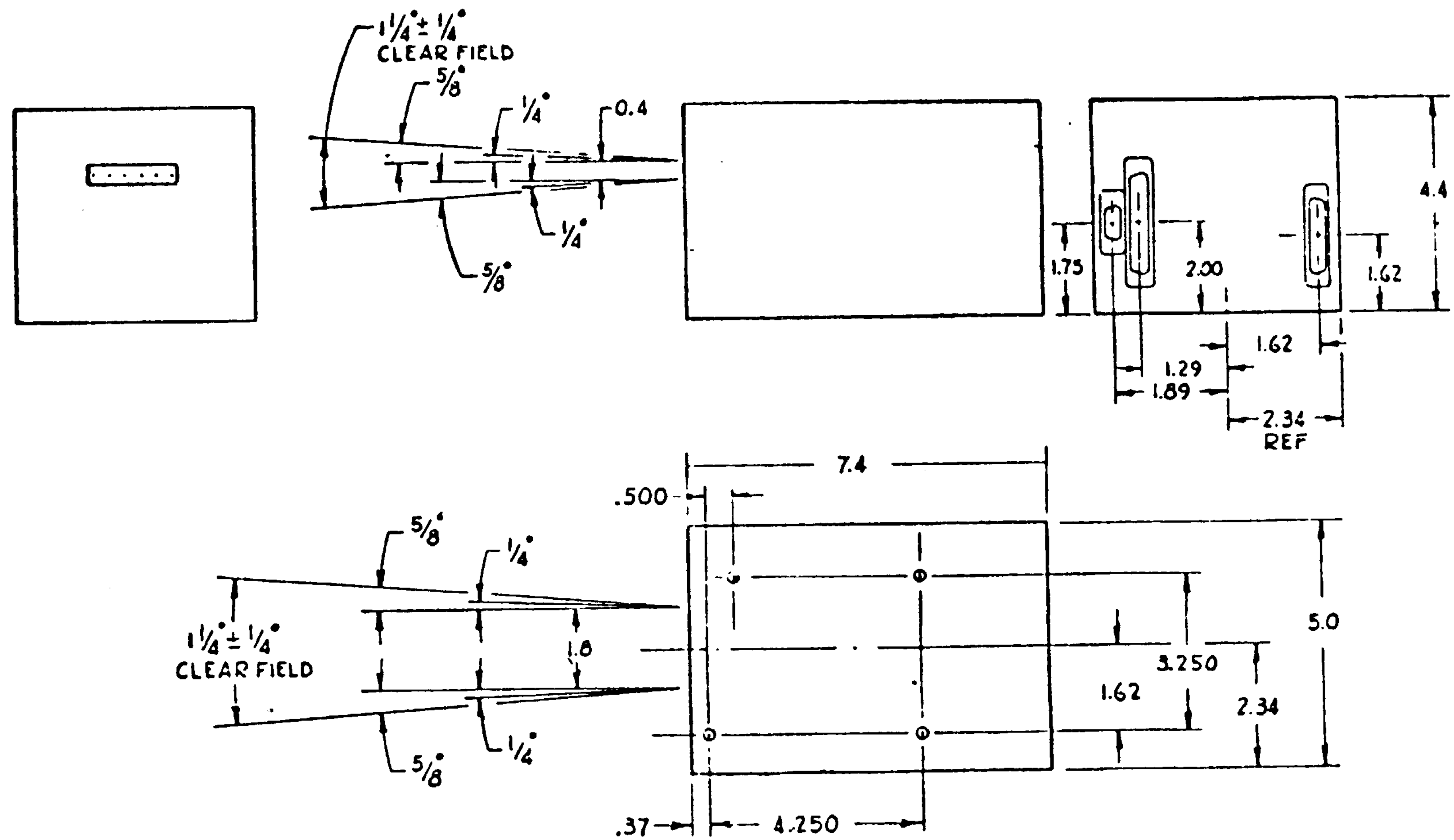
DESCRIPTION: The ultraviolet spectrometer is a subsystem which includes two electronically and mechanically independent spectrometers: (1) an occultation ultraviolet subsystem and (2) an airglow ultraviolet subsystem. The existence of an atmosphere on Mercury will be determined by using one of the spectrometers to observe the atmosphere during solar occultation in 4 channels - 475, 740, 810 and 890 Å - each having a 40 Å bandwidth. The second spectrometer will be used to observe airglow emissions from the Earth, Mercury, Venus and background sources in 10 channels - 304, 584, 744, 736, 867 to 879 Å, 1048, 1216, 1304 and 1657 Å. The second spectrometer will observe the emissions from the neutral constituents H, H_e, H_e^+, C, O, A and N_e. A plane grating will be used at grazing incidence to reflect the extreme ultraviolet radiation into the Channel multiplier detectors. The grating will have 300 grooves per mm. Fixed slits and detectors are placed to receive the wavelengths of interest. Photon pulses from the extreme ultraviolet detectors go to the preamplifiers. The output signal of each extreme ultraviolet detector is amplified at a fixed gain and routed to a discriminator. The discriminator generates an output signal if the input pulse exceeds a minimum value. The discriminator output will be in the form of a narrow pulse.

PARAMETER SUMMARY:

Dimensions:	Occultation - 18.8 x 12.7 x 11.2 cm (7.4 x 5.0 x 4.4 in.) Airglow - 38.1 x 11.9 x 14.5 cm (15.0 x 4.7 x 5.7 in.)
Weight:	6.1 kg (13.5 lbs)
Power:	6.0 W
Range:	First Spectrometer - 40 Å bandwidth for 475, 740, 810 and 890 Å Second Spectrometer - 304, 584, 744, 736, 867 to 879, 1048, 1216, 1304 and 1657 Å
Temperature Range:	Operating - -20° C to 40° C (-4.0° F to 104.0° F) Non-operating - -20° C to 75° C (-4.0° F to 167° F)
Sensitivity:	10^{14} atoms per cm^{-2}
Maximum Pulse Rate:	10^5 pulses per sec
Field of View:	Occultation - 1/4° circular Airglow - 1/8° x 3.6°
Power Subsystem:	50 VAC, 2.4 kHz
Sensitivity:	2 pulses/sec/rayleigh
Sample Rate:	2 times every 1.2 sec
Occultation UVS:	(a) The power subsystem shall supply the occultation UVS with primary power of 50 V, 2.4 kHz square wave AC: 2.3 W maximum, 2.0 W nominal. (b) Heater power of 2.0 W nominal and 2.3 W maximum will be supplied during all phases of the mission when the unit is not operating.
Airglow UVS:	(a) The power subsystem shall supply the Airglow UVS with primary power of 50 V, 2.4 kHz square wave AC: 4.4 W maximum, 3.9 W nominal. (b) Heater power of 3.9 W nominal and 4.4 W maximum will be supplied during all phases of the mission when the unit is not operating.

SOURCE:

Data:	NASA, Release No. 70 - 126, 28 July 1970. NSSDC AIM Print-out (2 October 1972), ID No. MARIN-J-05.
Reference:	JPL, Functional Requirement Mariner Venus/Mercury 1973 Spacecraft Ultraviolet Spectrometer Subsystem, No. MVM 73-4-2034, 2 December 1971.



Mariner J Ultraviolet Spectrometer

EXPERIMENT CATEGORY: Infrared Radiometry

DATE OF LAUNCH: October, 1973

INSTRUMENT NAME: Infrared Radiometer

SPACECRAFT: Mariner J (MVM '73)

DESTINATION: Venus/Mercury

PRINCIPAL INVESTIGATOR: S.C. Chase, Jr., Santa Barbara Research Center

INSTRUMENT CONTRACTOR:

PURPOSE: To measure the thermal emission from the surface of Mercury and Venus. To aid in identifying Venus cloud features by temperature measurements.

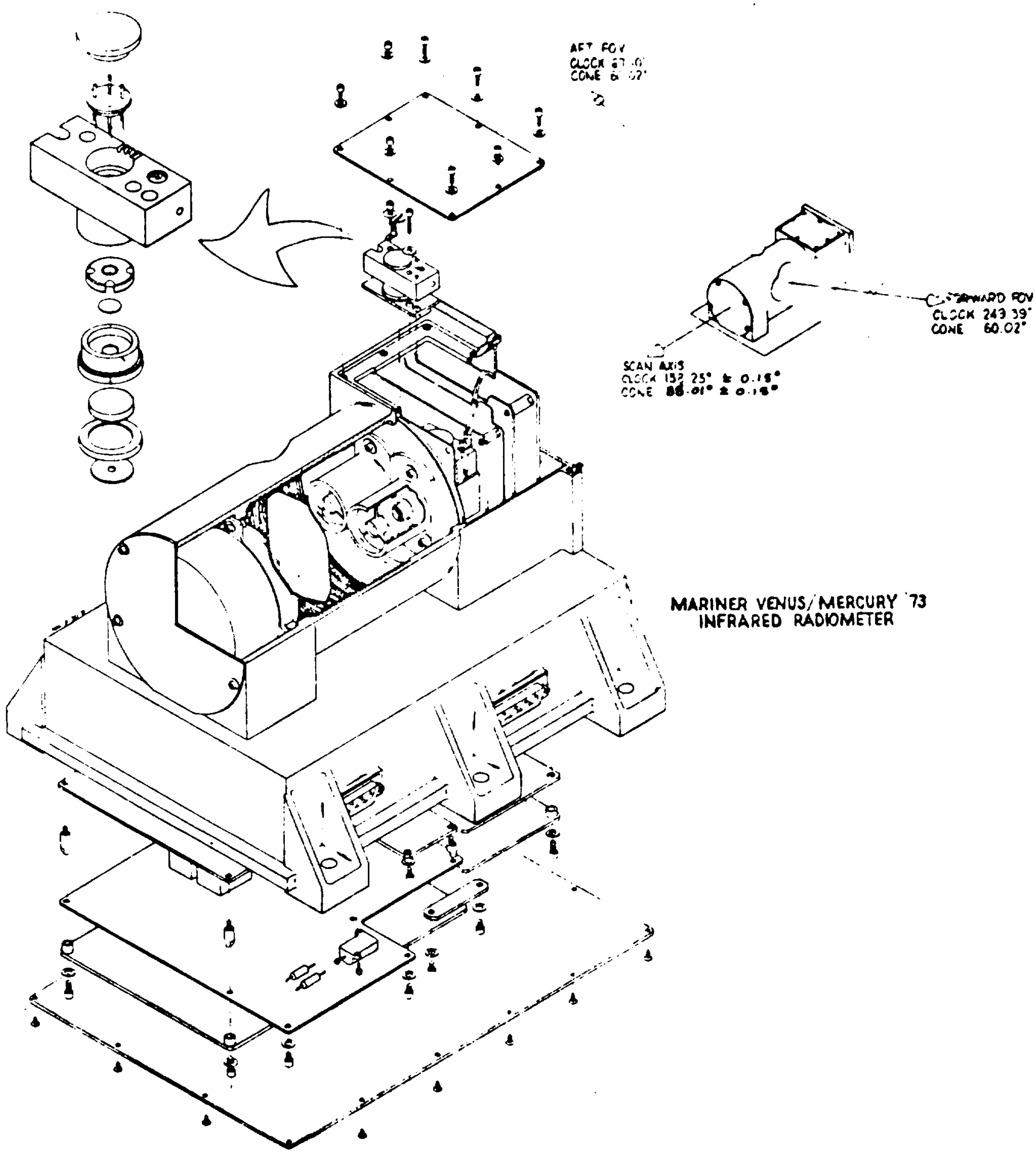
DESCRIPTION: This instrument consists of an infrared radiometer with dual (fore and aft) telescopes with 1/2° FOV and two detectors of 30 junction antimony-bismuth thermopiles each. The three-position scan mirror, driven by a digital stepping motor, selects radiation to be measured from three sources: (1) space, (2) planet, and (3) the thermal reference surface. The optical system consists of the object space scan mirror, and two one inch diameter Cassegrainian reflecting telescopes with refracting relay optics. The telescope has a focal length of six inches. The secondary mirror obscures 20% of the aperture area. Both telescopes have a field of view which is 0.5° diameter and coincident in object space. The FOV's are defined by 0.1 cm (0.052 in.) diameter apertures placed in the focal plane of the telescope. Two identical detectors are multi-junction antimony-bismuth thermopiles. The detectors are round with the junctions arranged radially. The active area of the detector is supported by a thin aluminum oxide film which is stretched across an annular sapphire disk. During bench checks and systems tests, the detector assemblies are back filled with Xenon gas which provides a protective environment and also allows a higher detector responsivity than would be possible in air or nitrogen. To develop full sensitivity, the thermopiles must be evacuated. Accordingly, before calibrations, (which are done in vacuum) or before launch, the plugs are removed.

PARAMETER SUMMARY:

Dimensions:	15.2 x 14.6 x 24.8 cm (6.0 x 5.7 x 9.7 in.) .05 cm (.02 in.) in diameter for detector
Weight:	3.7 kg (8.2 lbs)
Power:	2.5 W
Spectral Range:	7.5 to 14.0 micrometers 34.0 to 55.0 micrometers
Signal-to-Noise Ratio:	7.5 to 14.0 micrometers - 364:1 at 200° K and 52,500:1 at 700° K 34.0 to 55.0 micrometers - 12.4:1 at 80° K and 523:1 at 340° K
Dynamic Range:	80° K to 700° K
Sensitivity:	0.7° K at 100° K and 0.32° K at 700° K
Resolution:	At flyby distance of 1,000 km, surface coverage is a circle 8.7 km in diameter when viewing the sub-spacecraft point
Detector Time Constant:	Approximately 93 msec
Resistance of the Thermopiles:	Approximately 10.7 kilohms
Responsivity of the Detectors:	Approximately 270 V per W
Bandwidth:	0.64 Hz
Temperature Range:	Operating Temperature - from -20° to + 45° C Normal Encounter Temperature - 0° ± 20° C Storage Temperature - from -45° C to + 60° C

SOURCE:

Data:	NASA, Release No. 70-126, 28 July 1970 NSSDC AIM Printout (2 October 1972), ID No. MARIN-J-06.
Reference:	JPL, Functional Requirement Mariner Venus/Mercury 1973 Infrared Radiometer Subsystem, MVM 73-4-2038, 10 November 1971.



Mariner J Infrared Radiometer

EXPERIMENT CATEGORY:	Ionizing Radiation, High Energy Charged Particles
DATE OF LAUNCH:	October, 1973
INSTRUMENT NAME:	Charged Particle Detector
SPACECRAFT:	Mariner J (MVM '73)
DESTINATION:	Venus/Mercury
PRINCIPAL INVESTIGATOR:	J.A. Simpson, University of Chicago
INSTRUMENT CONTRACTOR:	

PURPOSE: To measure chemical and isotopic species of charged nuclei over wide energy range critical for the study of solar charged particle bombardment of Mercury. To search for trapped high energy electrons and protons in possible magnetosphere of Mercury.

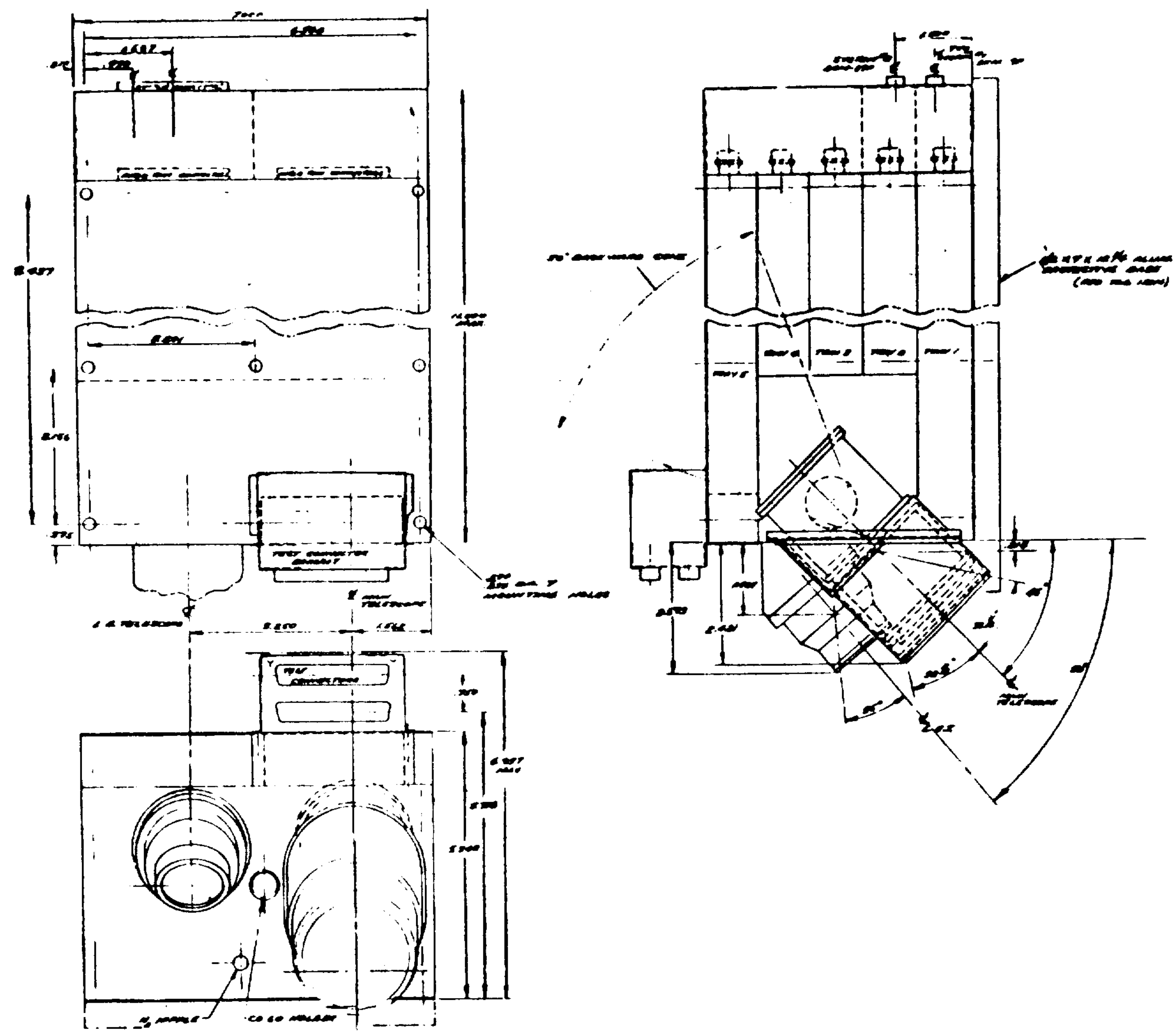
DESCRIPTION: The instrument contains two telescope assemblies, each requires an unobstructed view cone for accepting charged particles of 70°. These telescopes are the main telescope (MT) and the low energy telescope (LET). The construction of each is such that the detector array and mechanical housing assembly define the effective field of view. There is a backward field of view of 50° for the main telescope which can tolerate 1-2 gm/cm^2 material in the field of view. The main telescope consists of 7 detectors. Detectors D1, D2, D3, D4 and D6 are lithium-drifted solid state silicon detectors; D5 is a CsI crystal coupled to a solid state photodiode and D7 is a plastic scintillator used in conjunction with a photomultiplier tube. D7 is used in anti-coincidence with the other detectors to define the telescope acceptance cone and backward cone and, in addition, to provide a measure of the total flux of particles incident upon the instrument. The LET consists of three detectors: L1, a very thin conventional surface barrier detector; LA, an annular lithium-drifted n-i-p detector; and Lf, a flat lithium-drifted windowless detector. Detectors LA and LF are electrically connected so as to be equivalent to a single detector. The field of view of the LET is defined by the mechanical enclosure and by the geometrical configuration of the detectors relative to each other. The photomultiplier tube is optically coupled to the plastic scintillator to provide high gain response to the scintillation light pulses which occur as a result of passage of a charged particle through the plastic.

PARAMETER SUMMARY:

Dimensions:	47.2 x 17.5 x 17.8 cm (18.6 x 6.9 x 7.0 in.)
Weight:	3.7 kg (8.1 lbs)
Power:	1.7 W
Range:	(Main Telescope) Electrons - 200 keV to 15 MeV Ions - 0.6 to 500 MeV/nucleon (H-O) (Low Energy Telescope) Protons - 0.4 to 9 MeV Alpha Particles - 1.6 to 25 MeV (total energy) Fluxes of Nuclei - above 0.4 MeV
Volume:	Mounting Base - 17.8 x 27.9 cm (7.0 x 11.0 in.) Maximum Envelope Dimensions - 34.5 cm (13.6 in.) to the end of the telescope extension x 17.8 cm (7.0 in.) x 15.2 cm (6.0 in.) Volume - 9,424.2 cubic cm (575 cubic in.)
Pointing Accuracy:	± 1.0° with respect to the spacecraft coordinates
Temperature Range:	Allowable Operating Temperature - -20 to + 40° C Allowable Non-operating Temperature - -30 to + 50° C In-flight, Operating, Temperature Control Design Range - -10 to ± 20° C

SOURCE:

Data:	NASA, Release No. 70-126, 28 July 1970
Reference:	JPL, Functional Requirement Mariner Venus/Mercury 1973 Spacecraft Charged Particle Telescope Subsystem, MVM 73-4-2033, 8 November 1971.



Mariner J Charged Particle Detector

EXPERIMENT CATEGORY: Magnetic Field

DATE OF LAUNCH: October, 1973

INSTRUMENT NAME: Fluxgate Magnetometer Subsystem

SPACECRAFT: Mariner J (MVM '73)

DESTINATION: Venus/Mercury

PRINCIPAL INVESTIGATOR: N.F. Ness, Goddard Space Flight Center

INSTRUMENT CONTRACTOR:

PURPOSE: To make vector measurements of the magnetic field in the vicinity of Mercury and Venus and in the interplanetary medium. The experiment will provide the first measurements of solar wind interaction with Mercury and determine its magnetic field, if any.

DESCRIPTION: This subsystem consists of two fluxgate magnetometers mounted on a 6.0 m (20.0 ft) boom measuring magnetic field intensity in ± 16 and ± 128 gamma ranges along three mutually orthogonal axes. One magnetometer is located near the end of the rigid extendable boom in order to reduce the effect of the spacecraft field as much as possible. The second magnetometer is mounted inboard by approximately 2 to 3 meters in order to monitor the spacecraft magnetic field as well as the ambient field. The true ambient field direction and magnitude is deduced by mathematical operations performed on the data at the experimenter's facility. The sensor operation is as follows: the core of each sensor of the magnetometer is cyclically magnetically saturated at its operating frequency. The second harmonic content generated is due to the presence of a magnetic field, and is sensed to yield a magnetic field component parallel to each axis of each sensor. Operating frequencies for the two sensors will be different and will be selected from the following three frequencies: 10.17 kHz, 8.96 kHz, and 7.75 kHz. The outboard sensor is equipped with a mechanism using a heat operated toggle actuator. When current is applied, the flipper, as it is called, causes the X and Z axes of the sensor to rotate through a fixed angle of 180.0° about the Y axis. The motion reverses the apparent direction of the X and Z field components and enables deduction of any zero offsets in those axes. The flip motion is used in conjunction with a spacecraft maneuver in which the spacecraft is rolled 360° about the Z axis. This latter motion allows a similar deduction of an apparent zero offset in the X and Y components. The roll action does not separate the spacecraft magnetic field component from the instrument zero offset and is therefore not as explicit, mathematically, as would be desired. A statistical approach will be used to arrive at the instrument zero through exercise of these two motions together.

PARAMETER SUMMARY:

Dimensions:	Sensors - 12.7 cm (5.0 in.) in diameter x 30.5 cm (12.0 in.) in length Electronics - 2 modules, each 3.8 x 16.8 x 35.6 cm (1.5 x 6.6 x 14.0 in.) Boom - 2 sections each 302.3 cm (119.0 in.)
Weight:	11.1 kg (24.5 lbs)
Power:	8.6 W
Range:	0.46 to 1 AU
Sensitivity:	0.02 gamma zero drift, 0.5 gamma bias up to 3 K gamma
Dynamic Range:	± 16 gamma and ± 128 gamma for each axis of each sensor
Bias Offsets:	± 3060 gammas in 511 steps of 12 gamma for each axis
Quantization Sensitivity:	± 0.016 gamma ± 0.128 gamma
Sensor Noise:	0.029 gamma rms for 0 to 7.5 Hz bandwidth
Instrument Bandwidth:	0 to 7.5 Hz
Zero Level Stability:	± 0.5 gamma over 2 years
Data Bit Error Rate:	Less than 1 x 10^{-3} bits/bit

SOURCE:

Data:	NASA, Release No. 70-126, 28 July 1970. NSSDC AIM Printout (2 October 1972), ID No. MARIN-J-04.
Reference:	JPL, Functional Requirements Mariner Venus/Mercury 1973 Flight Equipment Fluxgate Magnetometer Subsystem, No. MVM 73-4-2035, no date.

Electrical Power Consumption Watts

2.4 KHz Supply Voltage	100% Duty		Variable Duty*		3 to 10 Minutes During Roll Calibration	
	Instrument		Thermal		Flipper	
	A	B	A	B	A	B
48V	2.531	2.531	1.75	1.29	4.60	-
50V	2.665	2.665	1.90	1.40	5.00	-
51.5V	2.74	2.74	2.02	1.48	5.3	

* Thermal power requirements are expected to be reduced to a 50% duty cycle or less prior to Mercury encounter. The magnetometer does not use replacement heaters.

Equipment Temperature Limits in Deg Fahreheit (Centigrade)

Status	Item	Allow Long Term > 1 Hr	Short Term	Preferred	Max Ground (In Air) Oper
Operating	Electronics	+ 14 to 122 (- 10 to 50)	14 to 122 (-10 to 50)	50 to 90 (10 to 32)	122 (50)
	Magnetometer	- 40 to +122 (- 40 to 50)	- 40 to 122 (-40 to 50)	32 to 104 (0 to 40)	122 (50)
	Boom	- 148 to 167 (- 100 to 75)	- 148 to 167 (- 100 to 75)	32 to 104 (0 to 40)	122 (50)
Non-Operating	Electronics	32 to 122 (0 to 50)	32 to 131 (0 to 55)	50 to 90 (10 to 32)	-
	Magnetometer	- 58 to 212 (- 50 to 50)	- 58 to 212 (- 50 to 100)	32 to 104 (0 to 40)	-
	Boom	- 148 to 167 (- 100 to 75)	- 148 to 167 (- 100 to 75)	32 to 104 (0 to 40)	-

EXPERIMENT CATEGORY: Plasma

DATE OF LAUNCH: October, 1973

INSTRUMENT NAME: Plasma Science Experiment

SPACECRAFT: Mariner J (MVM '73)

DESTINATION: Venus/Mercury

PRINCIPAL INVESTIGATOR: H.S. Bridge, M.I.T.

INSTRUMENT CONTRACTOR:

PURPOSE: To determine the mode of interaction between the planet Mercury and the solar wind, and to make a comprehensive study of the plasma regime at Mercury. To verify and extend previous observations of the solar wind interaction with Venus and, in particular, to clarify the role of electrons in the interaction. To investigate the characteristics of the solar plasma between 1 and 0.4 AU.

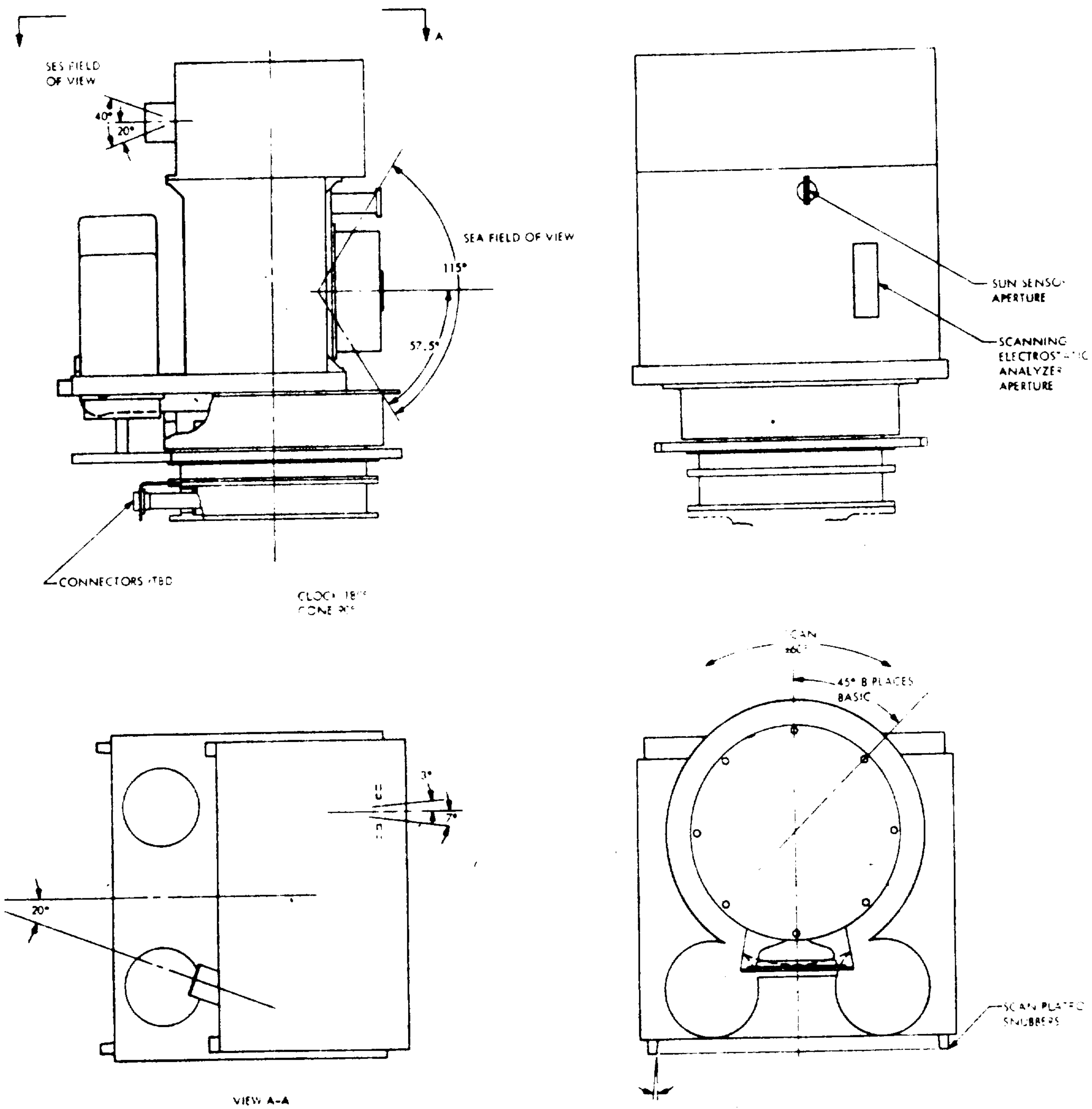
DESCRIPTION: The instrument is a principal detector system (pair of solar-viewing, nested, hemispherical electrostatic analyzers) and an auxiliary detector system (antisolar viewing single electrostatic analyzer). Both detectors are mounted on a scanning platform which is mounted external to the spacecraft octagon structure by means of a boom. The forward-looking detector system is identified as the Scanning Electrostatic Analyzer (SEA), and the backward-looking detector system is identified as the Scanning Electron Spectrometer (SES). The SEA is designed to measure positive ions and electrons. The charged particle analyzer consists of three nested hemispherical plates with a common electron multiplier particle detector. The center analyzer plate in conjunction with the inner and outer plates form two separate particle channels. One channel selects positive ions within a specified energy-per-unit-charge range, while the other selects electrons in a given energy interval. The rotational axis about which the analyzer scans is approximately normal to the ecliptic plane and the "acceptance fan" is in a meridian plane parallel to this axis. The SES consists of a single hemispherical electrostatic analyzer mounted on the scan platform so that its viewing axis is displaced approximately 190° in azimuth relative to the SEA viewing axis.

Electrons transmitted by the analyzer are counted by a Channeltron electron multiplier. Electron energy discrimination is accomplished by applying a fixed voltage to the analyzer plates for a given time. The energy range is covered in 15 exponentially related steps.

PARAMETER SUMMARY:

Dimensions:	
Weight:	9.2 kg (20.2 lbs)
Power:	5.4 W
Energy Coverage:	(a) Ions - energy/charge range - 80 to 8000 V, 10.5 % resolution for SEA. (b) Electrons - energy range - 6 to 1250 eV, 33.0% resolution for SEA; 12.5 to 671 eV, 10.0 % resolution for SES.
Angular Coverage:	(a) S.E. longitude - ± 60° (sunward) range, ± 1° resolution for SEA, ± 60° (anti-sunward) range, ± 3° resolution for SES. (b) S.E. latitude - ± 60° range for SEA, ± 20° range for SES
Flux Sensitivity:	(a) Omni $(cm^2\ sec\ ster\ keV)^{-1}$: Ions - 2 x 10^5 at 1 kV for SEA Electrons - 1.2 x 10^6 at 100 eV for SEA 5 x 10^4 at 1 keV for SES (b) Directed $(cm^2\ sec)^{-1}$: Ions - 60 at 1 kV for SEA
Dynamic Range:	8,000 for SEA: 30,000 for SES
Time for Energy Spectrum:	0.392 sec for SEA; 6 sec for SES
Cycle Time	(Time for energy angle scan) 30 sec (high rate) 120 sec (low rate)
Telemetry (bps):	HBR - 542 LBR - 107

Volume:	18,029 cc (1100 cu in.)
Temperature:	0 to 50° C
SOURCE:	
Data:	NASA, Release No. 70-126, 28 July 1970. NSSDC AIM Printout (2 October 1972), ID No. MARIN-J-03.
Reference:	JPL, Functional Requirements Mariner Venus/Mercury 1973 Plasma Science Experiment, MVM '73-4-2032, 4 January 1972.



Mariner J Plasma Science Experiment

EXPERIMENT CATEGORY: Visible Frequency, Cameras

DATE OF LAUNCH: October, 1973

INSTRUMENT NAME: Television Science

SPACECRAFT: Mariner J (MVM '73)

DESTINATION: Venus/Mercury

PRINCIPAL INVESTIGATOR: B.C. Murray, C.I.T.

INSTRUMENT CONTRACTOR:

PURPOSE: To obtain high resolution (1 km) ultraviolet imagery of Venusian cloud patterns and circulation. To obtain full mosaic of lit disc of Mercury at 0.85 - 1.6 km resolution. To map and identify the major physiographic provinces of Mercury.

DESCRIPTION: The television science experiment comprises two cameras and an auxiliary electronics subassembly mounted on the spacecraft scan platform and support electronics housed in the bus portion of the spacecraft. The two cameras are narrow angle 700 x 835 pixel television cameras with 1500 mm Cassegrain telescopes. A color filter wheel and a wide angle lens mounted on a shutter/filter wheel subchassis are included. The lens images on the vidicon through a fiber optics plate, a relay lens, and a mirror mounted in one position of the filter wheel. The automatic exposure control sensor and optics are mounted in a closed tube on the main telescope. A single element lens images energy on a photodiode whose output is used to set the exposure time of the camera in the automatic mode. This unit is boresighted with the telescope to within 1.75 milliradians. When the wide angle image relay mirror is in position, the image from the main telescope is blocked and only the wide angle image is seen by the vidicon. The camera heads are identical for both cameras and house the sensor vidicons, yoke assemblies, preamplifiers, bandpass filters, post amplifiers, cathode chopping drive, high voltage power supplies, and control circuitry for target, calibrate, and GI erase switching.

PARAMETER SUMMARY:

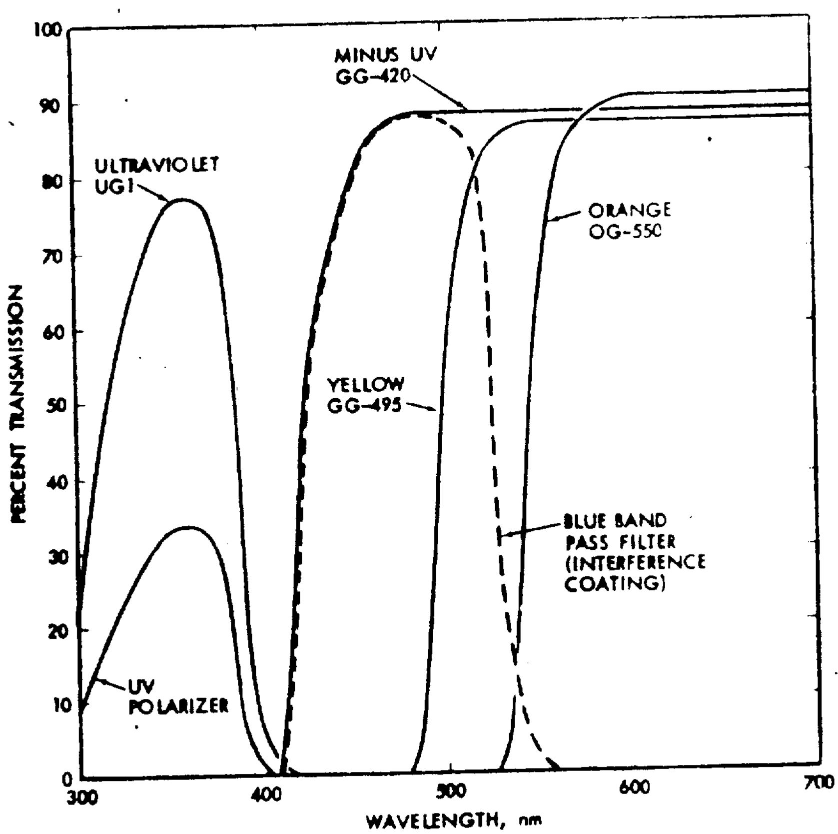
Dimensions:	
Weight:	43.6 kg (96.0 lbs)
Power:	67.0 W
Telescope:	Focal Length - 1500 mm ± 5% Field of View - 6.4 x 8.2 milliradians Assembly Focal Ratio - f/8.5 Maximum Assembly T Number - 14.0 Maximum Modulation Transfer Function - 50% @ 33 Line Pairs/mm
Wide Angle Lens:	Focal Length - 50 mm Field of View - 192 x 244 milliradians (Maximum) Assemble Focal Ratio - f/12 Maximum Assembly T Number - 18.0 Maximum Transmittance - 80% Min. (400 - 650 nm) Modulation Transfer Function - 50% @ 15 Line Pairs/mm
Automatic Exposure:	(Control Characteristics) Focal Length - 75 mm Field of View - 13 milliradians (diameter) Assembly Focal Ratio - 1.50 Assembly T Number - 1.77 Sensor Type - Silicon PIN Photodiode Sensor Active Area (Effective) - 0.3 mm^2 (0.62 mm diameter)
Filter Wheel	(Equipment Complement) (Eight selectable positions) 1. Minus ultraviolet high-pass filter 2. Defocusing lens (Fabry lens) in-flight calibration 3. Orange bandpass filter 4. Ultraviolet bandpass filter 5. Blue bandpass filter 6. Ultraviolet polarizing filter 7. Yellow bandpass filter 8. Wide angle image relay mirror
Cameras Performance Characteristics:	Aspect Ratio - 1.30:1 Active Scan Lines Per Frame - 700 Frame Time - 42 Sec Total Line Time - 60 msec Active Line Time - 56.5 msec Line Sync Time - 3.4 msec Approx. Black Mask Time - 1.0 msec Active Picture Elements Per Line - 832 Bits/Picture Element - 8

Video Carrier Frequency - 28.8 kHz
Video Base Band - 7:35 kHz
Video Sampling Frequency - 14.7 kHz
Video Pass Band - 21.45 to 36.15 kHz

SOURCE:

Data: JPL, Space Programs Summary 37-66, Vol. I, Flight Projects for the Period 1 September 1970 to 31 October 1970, 30 November 1970.
NASA, Release No. 70-126, 28 July 1970.
NSSDC AIM Printout (2 October 1972), ID No. MARIN-J-01.

Reference: JPL, Functional Requirement Mariner Venus/Mercury 1973 Television Subsystem, No. MVM '73-4-2036, 19 November 1971.



Mariner J Television Science Optical Filters

EXPERIMENT CATEGORY:	Atmospheric Composition
DATE OF LAUNCH:	November, 1973
INSTRUMENT NAME:	Atmospheric Density Accelerometer
SPACECRAFT:	AE-C
DESTINATION:	Earth Orbit
PRINCIPAL INVESTIGATOR:	K.S.W. Champion, Air Force Cambridge Research Laboratories (AFCRL)
INSTRUMENT CONTRACTOR:	Bell Aerospace, Buffalo, New York

PURPOSE: To determine the density of the neutral atmosphere in the altitude range 120-400 km by measurement of satellite deceleration due to aerodynamic drag. This accelerometer also will be utilized to monitor the thrust of the orbit adjust propulsion system (OAPS); to determine satellite minimum altitude; and to measure spacecraft roll in the despun mode and attitude sensing.

DESCRIPTION: Three single axis sensors will be used in a triaxial configuration. The sensitive axes of two of the sensors will be in the spacecraft xy plane. The third sensor will be along the satellite spin (z) axis. Three sensitivity ranges will be used to cover the range of accelerations to be measured. The sensing portion of the instrument consists of an electrostatically supported proof mass that is electrostatically pulse-balanced along the preferred sensitive axis. The proof mass cylinder is suspended radially by pairs of electrodes on the electrode carrier. Each electrode in a series with a tuning inductor. The capacitance in each series-tuned circuit changes as a function of the relative displacement of the proof mass from the support electrode. An acceleration of the MESA case will cause the proof mass to move relative to the case in the opposite direction. Detection of this movement is accomplished by an extremely sensitive balanced capacitance bridge circuit.

PARAMETER SUMMARY:

Dimensions:

Weight: 8.8 kg (19.4 lbs)

Power:	5 W
Altitude Range:	120 to 400 km
Dynamic Range:	(Acceleration) 8×10^{-3} g to 4×10^{-8} g

SOURCE:

Data:	NSSDC AIM Printout (2 October 1972), ID No. AE-C-02.
Reference:	Goddard Space Flight Center, Brief Descriptions of Atmosphere Explorer C, D & E Experiments, September, 1972.

EXPERIMENT CATEGORY: Atmospheric Composition

DATE OF LAUNCH: November, 1973

INSTRUMENT NAME: Bennett Ion Mass Spectrometer

SPACECRAFT: AE-C

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: H.C. Brinton, NASA/GSFC

INSTRUMENT CONTRACTOR: Aero Geo Astro, College Park, Maryland

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PURPOSE: To measure, throughout the AE orbit, the individual concentrations of all thermal positive ions in the mass range 1 to 72 AMU, and ambient density range 5 ions/cm^3 to 5 x 10^6 ions/cm^3.

DESCRIPTION: This instrument draws ambient atmospheric ions into it by a negative orifice field and will be accelerated down the axis of the spectrometer by a slowly varying sweep potential. For each ion mass, there is a value of the sweep that will accelerate the ion to the resonant velocity of the instrument. Those ions that traverse the tube at the resonant velocity will gain energy from the RF field in the three analyzer sections of the spectrometer and will thus be able to pass through a retarding potential field and reach the collector at the end of the tube. An electrometer will convert the collector current to a voltage that will then be processed by an amplifier having a dynamic range corresponding to currents from 5 x 10^{-14} amp to 5 x 10^{-8} amp. The amplifier output will be compressed into a single analog telemetry channel, and this, along with an analog monitor of the sweep potential, will constitute the primary data output. Additional processing of the amplifier output will permit the primary experiment data to be read out in the form of two digital words, one indicating the current and the other the sweep potential measured for each ionic constituent.

PARAMETER SUMMARY:

Dimensions:

Weight: 4.0 kg (8.8 lbs)

Power:	2 W
Range:	1 to 72 AMU
Ambient Density Range:	5 Ions/cm^3 - 5 x 10^6 Ions/cm^3
SOURCE:	
Data:	NSSDC AIM Printout (2 October 1972), ID No. AE-C-11.
Reference:	Goddard Space Flight Center, Brief Descriptions of Atmosphere Explorer C, D & E Experiments, September, 1972.

EXPERIMENT CATEGORY: Atmospheric Composition

DATE OF LAUNCH: November, 1973

INSTRUMENT NAME: Cylindrical Electrostatic Probes

SPACECRAFT: AE-C

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: L.H. Brace, NASA/GSFC

INSTRUMENT CONTRACTOR: Universal Monitor, Pasadena

PURPOSE: To measure electron density and temperature in the atmosphere.

DESCRIPTION: This probe is a retarding potential (Langmuir type) probe measuring the current flowing to the collector for a known saw-toothed voltage pattern. Applied on the probe are two cylindrical collectors three inches long and 0.2 cm (0.08 in.) in diameter. They are employed independently to provide partially redundant measurements. Both collectors are mounted on short booms that protrude into the undisturbed plasma surrounding the spacecraft. One sensor is mounted parallel to the spacecraft spin axis and thus remains perpendicular to the velocity vector whether the spacecraft is spinning or despun. It can provide continuous spin-free measurements. The second collector is mounted perpendicular to the spin-axis and sweeps through all angles relative to the velocity vector as the spacecraft spins. When despun, this sensor is also perpendicular to the flow. The collector surfaces consist of a layer of highly oriented tungsten crystals that are grown by a vapor deposition process. This type of surface provides a highly uniform surface potential, thus reducing the "energy smearing" in the measurement of Te.

PARAMETER SUMMARY:

Dimensions:

Weight: 2.7 kg (6.0 lbs)

Power:

Range:

SOURCE:

Data:	NSSDC AIM Printout (2 October 1972), ID No. AE-C-01.
Reference:	GSFC, Brief Descriptions of Atmosphere Explorer C, D & E Experiments, September, 1972.

EXPERIMENT CATEGORY: Atmospheric Composition

DATE OF LAUNCH: November, 1973

INSTRUMENT NAME: Low Energy Electron Detectors

SPACECRAFT: AE-C

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: R.A. Hoffman, NASA/GSFC

INSTRUMENT CONTRACTOR:

PURPOSE: To monitor the energy input into the upper atmosphere due to electrons and protons by direct measurements of particle energy spectra and pitch angle distributions; to determine the characteristics of field aligned currents in the auroral zone; and to study the magnetospheric substorm precipitation in detail with complete electron measurements.

DESCRIPTION: This instrument consists of three detectors each comprised of an electrostatic analyzer and channel electron multiplier. The sensors will make measurements of both electrons and protons between 0.2 and 25 keV in 16 energy steps in order to obtain good energy spectra. The remaining detectors will make measurements continuously. The energies listed are the center energies of the passband, which is about ± 10% of each center energy. The angular response of each detector is about ± 3.5°.

PARAMETER SUMMARY:

Dimensions:

Weight: 4.3 kg (9.5 lbs)

Power: *

Range: Electrons & Protons - 0.2 to 25 keV

SOURCE:

Data: NSSDC AIM Printout (2 October 1972), ID No. AE-C-12.

Reference: Goddard Space Flight Center, Brief Descriptions of Atmosphere Explorer C, D & E Experiments, September, 1972.

EXPERIMENT CATEGORY: Atmospheric Composition

DATE OF LAUNCH: November, 1973

INSTRUMENT NAME: Magnetic Ion Mass Spectrometer

SPACECRAFT: AE-C

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: J.H. Hoffman, University of Texas

INSTRUMENT CONTRACTOR:

PURPOSE: To measure the relative abundances of the ambient positive ions in three different mass ranges sampled from the ionosphere by employing a magnetic momentum selector and detector system.

DESCRIPTION: This instrument is a magnetic deflection mass spectrometer that consists of an entrance aperture (oriented to look out of the satellite equator normal to the spin axis), an electrostatic analyzer, and a magnetic analyzer. The electric and magnetic fields are arranged to produce a mass spectrum along a focal plane following the magnetic analyzer. Three slits are placed along the focal plane in appropriate places to simultaneously collect ions in the mass ratio 1:4:16. Following each slit is an electron multiplier and log electrometer amplifier detector, the output of which will be digitized to eight-bit words at 1600 words per sec. A 'peaks' circuit will operate on these digital data to determine the amplitude of each peak in the spectrum. Only the amplitude of each peak will be telemetered, and, thus, only one word per peak is required. The instrument operates without an ion source, collecting positive ions from the ambient ionosphere.

PARAMETER SUMMARY:

Dimensions:

Weight: 7.5 kg (16.6 lbs)

Power: 7 W

Mass Ranges: 1-4, 4-16, 16-64 AMU

SOURCE:

Data: NSSDC AIM Printout (2 October 1972), ID No. AE-C-10.

Reference: Goddard Space Flight Center, Brief Descriptions of Atmosphere Explorer C, D & E Experiments, September, 1972.

EXPERIMENT CATEGORY: Atmospheric Composition

DATE OF LAUNCH: November, 1973

INSTRUMENT NAME: Neutral Temperature Sensor

SPACECRAFT: AE-C

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: N.W. Spencer, NASA/GSFC

INSTRUMENT CONTRACTOR:

PURPOSE: To measure the kinetic temperature through determination of the instantaneous density, neutral N_2 in a spherical chamber which is coupled to the atmosphere through knife-edged orifice.

DESCRIPTION: This instrument is a quadrupole spectrometer. A sample of the thermalized gas from the spherical chamber will be passed to a small dual filament ion source that will produce an ion beam proportional to the chamber density. The ion beam will be directed into the quadrupole analyzer that will pass ions with a mass-to-charge ratio of 28 (molecular nitrogen) to an electron multiplier. Here the individual ions at the input will produce pulses that will be counted at the multiplier output. Analysis of the variation of the concentration in the chamber, with knowledge of the satellite velocity and orientation, will permit a determination of the ambient kinetic temperature of molecular nitrogen. A total atmospheric density measurement will be obtained through the use of an alternative mode of operation of the system. The sensor will be baked, vacuum-sealed prior to launch, and opened to the atmosphere after the spacecraft is in orbit. The overall system is digital rather than analog in concept and accordingly permits use of an electron multiplier in the counting mode and thus application of counting techniques.

PARAMETER SUMMARY:

Dimensions:

Weight: 8.5 kg (18.8 lbs)

Power:	10 W
Range:	
SOURCE:	
Data:	NSSDC AIM Printout (2 October 1972), ID No. AE-C-09.
Reference:	Goddard Space Flight Center, Brief Descriptions of Atmosphere Explorer C, D & E Experiments, September, 1972.

EXPERIMENT CATEGORY: Atmospheric Composition

DATE OF LAUNCH: November, 1973

INSTRUMENT NAME: Open Source Neutral Mass Spectrometer

SPACECRAFT: AE-C

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: A.O.C. Nier, University of Minnesota

INSTRUMENT CONTRACTOR:

PURPOSE: To obtain the number densities of the neutral atmospheric gases, particularly reactive species such as atomic oxygen, at the satellite location, and to determine quantitative measurements of trace constituents within the mass range of 1-48 AMU. These results will be used in a comprehensive study of the chemical, energetic and dynamic processes that control the structure of the thermosphere.

DESCRIPTION: This instrument is a double focusing Mattauch-Herzog magnetic deflection instrument with an electron bombardment ion source. Two ion collectors are employed, simultaneously collecting ions differing in mass by a factor of 8. Mass spectra are swept continuously, or stepwise, by varying the ion accelerating voltage. The total mass range covered is 1-48 AMU. Ions entering the high mass collector travel in a 3.81cm(1.50 in.) radius arc in the magnetic analyzer. The ion source is relatively "open" to minimize the loss of reactive species such as atomic oxygen. Before launch, the instrument is maintained in an evacuated condition by a small ion-sputter pump. When orbit is reached, an aluminum cap covering the ion source is removed by a pyrotechnic device, exposing the ion source to the ambient atmosphere. Suitably placed grids covering the ion source minimize the external electric field of the source in order to prevent interference with other experiments on the spacecraft. The ionizing region is a cylindrical cavity .6 cm deep and 0.64 cm in diameter. The top of the cylindrical cavity is completely open. The walls are of pure aluminum as this material is believed to be among the very best from the standpoint of minimizing atomic oxygen loss.

PARAMETER SUMMARY:

Dimensions:

Weight: 6.9 kg (15.3 lbs)

Power: 8 W

Range: 1 - 48 AMU
2.5×10^{-14} to 4.8×10^{-9} amp up to 3×10^{6} counts/sec

Sensitivity: 10^{-5} amp/torr
2.5×10^{-12} to 4.8×10^{-4} torr partial pressure

SOURCE:

Data: NSSDC AIM Printout (2 October 1972), ID No. AE-C-07.

Reference: Goddard Space Flight Center, Brief Descriptions of Atmosphere Explorer C, D & E Experiments, September, 1972.

EXPERIMENT CATEGORY: Atmospheric Composition

DATE OF LAUNCH: November, 1973

INSTRUMENT NAME: Photoelectron Spectrometer

SPACECRAFT: AE-C

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: J.P. Doering, John Hopkins University

INSTRUMENT CONTRACTOR:

PURPOSE: To measure the low energy electron flux in the thermosphere by means of two electrostatic deflection-type electron spectrometers. The overall experiment will provide general information on the intensity, angular distribution and energy spectrum of low energy electrons (range between 2 eV and 500 eV) in the vicinity of the spacecraft.

DESCRIPTION: This instrument consists of two electron spectrometer detector heads mounted 180° apart and protruding slightly through the exterior surface of the spacecraft. The detector heads will be connected to a common electronics system mounted inside the spacecraft which will contain command -, data processing -, calibration -, and telemetry interface circuits. Placement on the spacecraft has been arranged to minimize interference from shadowing of electron trajectories by the spacecraft and contamination of the observed spectra by locally generated photoelectrons. The photoelectron energy spectrum is scanned by sweeping the voltage between the two hemispherical deflection elements. The differential electron energy spectrum is thus produced directly by the analyzer, eliminating the need for differentiation of integral energy spectra. In order to trap high energy particles and photons which enter the analyzer through the electron path, a hole will be cut in the outer hemisphere behind the entrance aperture. A positively biased plate will be placed behind the hole to trap secondary electrons. To reduce the background from reflected secondary electrons and photons, a hole will also be cut in the outer hemisphere behind the exit aperture. A weak radioactive source will be placed behind the hole in the outer hemisphere opposite the exit aperture. This source is designed to provide a constant, low-level counting rate at the electron multiplier which will allow inflight gain calibration.

PARAMETER SUMMARY:

Dimensions:	
Weight:	4.2 kg (9.3 lbs)
Power:	
Range:	2 to 500 eV

SOURCE:

Data:	NSSDC AIM Printout (2 October 1972), ID No. AE-C-03.
Reference:	Goddard Space Flight Center, Brief Descriptions of Atmosphere Explorer C, D & E Experiments, September, 1972.

EXPERIMENT CATEGORY:	Atmospheric Composition
DATE OF LAUNCH:	November, 1973
INSTRUMENT NAME:	Quadrupole Mass Spectrometer
SPACECRAFT:	AE-C
DESTINATION:	Earth Orbit
PRINCIPAL INVESTIGATOR:	D.T. Pelz, NASA/GSFC
INSTRUMENT CONTRACTOR:	

PURPOSE:

To measure in-situ the concentrations and distributions of the neutral gas constituents in the thermosphere. This experiment is expected to provide the instantaneous and global distributions of neutral hydrogen, helium, atomic and molecular oxygen, nitrogen, argon, and total mass density above approximately 125 km altitude. Also to provide quantitative measurements of trace constituents within the mass range 1-45.

DESCRIPTION:

This instrument includes a spherical antechamber that will be coupled to the atmosphere through a knife-edged orifice. The gas in the antechamber is continuously sampled by the hot filament ion source which accelerates a beam of ions into the quadrupole mass filter. The ions of selected m/e ratio strike the first dynode of the off-axis electron multiplier. Amplified pulses out of the multiplier are counted to provide a measure of the density of the selected mass in the spherical antechamber, which is related to the ambient atmospheric density using the standard F (s) equation. The associated electronics consist of an electrode power supply and emission regulator, RF oscillator, detector, and logic subsystems. There will be three modes of operation. Mode 1 will consist of sequential stepping to preselected masses. Mode 2 will sweep the entire or selected segments of the range. Mode 3 will provide fixed tuning into a single mass or a few selected masses for extended periods.

PARAMETER SUMMARY:

Dimensions:	7.8 kg (17.3 lbs)
Power:	18 W

Range:	1-46 AMU
Resolution:	Better than 1 mass unit
Dynamic Range:	10^6
SOURCE:	
Data:	NSSDC AIM Printout (2 October 1972), ID No. AE-C-08.
Reference:	Goddard Space Flight Center, Brief Descriptions of Atmosphere Explorer C, D & E Experiments, September, 1972.

EXPERIMENT CATEGORY:	Atmospheric Composition
DATE OF LAUNCH:	November, 1973
INSTRUMENT NAME:	Retarding Potential Analyzer
SPACECRAFT:	AE-C
DESTINATION:	Earth Orbit
PRINCIPAL INVESTIGATOR:	W.B. Hanson, University of Texas
INSTRUMENT CONTRACTOR:	

PURPOSE: To provide ion temperature and total ion concentration, which it will do at least every five seconds. In addition, the instrument will measure the ion drift velocity and the thermal and suprathermal electron energy distributions.

DESCRIPTION: This instrument has three sensor heads spaced around the cylindrical face of the satellite that allow three ram measurements to be taken per spin, and permit evaluation of different sensor characteristics. In the oriented satellite mode, it also allows electron measurements to be made at different wake angles and solar directions. Most measurement operations are accomplished in a 0.75 second time period, during which the retarding grid is swept from its maximum value (+ 32 volts for ions, -46 V for suprathermal electrons, -3 V for thermal electrons) to vehicle ground potential. An additional ion mode with reverse voltage sweep is included, where a 3.4 kHz signal is superposed on the retarding grid. Derivatives of the ion current-voltage characteristic curve are obtained from this operation. The main sensor head, which faces into the ram when the satellite is oriented, also has a segmented collector behind a separate aperture. The distribution of ion current on the four collector segments, which is determined by the ion ram direction, is measured by a difference amplifier technique. Deviations of the ram direction from the satellite velocity vector, which can be interpreted in terms of ionospheric electric fields. Deviations of the normal velocity component from the satellite speed can be deduced from the ion current-voltage characteristic curves.

PARAMETER SUMMARY:

Dimensions:	
Weight:	5.1 kg (11.3 lbs)
Power:	
Range:	

SOURCE:

Data:	NSSDC AIM Printout (2 October 1972), ID No. AE-C-04.
Reference:	Goddard Space Flight Center, Brief Descriptions of Atmosphere Explorer C, D & E Experiments, September, 1972.

EXPERIMENT CATEGORY:	Atmospheric Composition
DATE OF LAUNCH:	November, 1973
INSTRUMENT NAME:	Solar EUV Spectrophotometer
SPACECRAFT:	AE-C
DESTINATION:	Earth Orbit
PRINCIPAL INVESTIGATOR:	H.E. Hinteregger, Air Force Cambridge Research Lab
INSTRUMENT CONTRACTOR:	Ball Brothers Research, Boulder, Colorado

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PURPOSE: To provide measurements of the incident, unattenuated solar fluxes at wavelengths ranging from 140 to 1850 A as well as of the monochromatic optical depths of atmospheric regions along the perigee-near part of the orbit and of the atmospheric regions around the points of minimum ray heights in occultation observations during sunrise and sunset.

DESCRIPTION: This instrument is a grating spectrophotometer consisting of 24 monochromators. Two monochromators time-share a common detector and associated electronics in the form of one of a total number of 12 "modules" which are arranged in the form of two "halves" of the instrument. The operations of scanning or selecting the grating-position steps for the scan-capable modules are also accomplished jointly within the same half of the instrument, but independent from the other half. This independence also applies to power, command and telemetry.

PARAMETER SUMMARY:

Dimensions:

Weight: 11.5 kg (25.4 lbs)

Power:

Range:

Spectral Resolution: 2 A at 300 A

SOURCE:

Data: NSSDC AIM Printout (2 October 1972) ID No. AE-C-06.

Reference: Goddard Space Flight Center, Brief Descriptions of Atmosphere Explorer C, D & E Experiments, September, 1972.

Monochromator Id. No.	WAVELENGTH SCAN RANGE or FIXED SETTING (in Angstrom)		FIELD OF VIEW (in arc minutes)	SPECTRAL BAND-WIDTHS (in Angstrom): Solar or Instr. Entrance	Instr. Exit	Half-Value Total	Module Id. No.	Aperture No.	EUVS-1	EUVS-2
1	142 - 208	scan-capable monochromators	60 x 60	1.9	3.5	2.7	1	1	x	
2	206 - 306		60 x 60	3.0	1.0	2.0		2		
3	321 - 406		60 x 60	1.4	3.4	2.4	2	1		x
4	401 - 530		60 x 60	3.5	1.7	2.6		2		
5	516 - 653		60 x 60	6.2	1.9	4.1	3	1	x	
6	989 - 1192		60 x 60	7.1	2.1	4.6		2		
7	656 - 876		60 x 60	12.0	4.0	8.0	4	1		x
8	1256 - 1696		60 x 60	24.6	26.0	25.3		2		
9	918 - 1049		60 x 60	2.3	1.3	1.8	5	1		x
10	788 - 922		60 x 60	3.6	7.0	5.3		2		
11	1226 - 1373		6 x 6	0.5	5.0	2.8	6	1	x	
12	1370 - 1851		6 x 6	5.3	15.0	10.2		2		
13	171	non-scan monochromators	10 x 6(or 60)	9.0	2.8	5.9	7	1	x	
14	256		10 x 6(or 60)	13.6	4.3	9.0		2		
15	304		6 x 6	11.9	2.2	7.1	8	1	x	
16	610		6 x 16	24.0	4.5	14.2		2		
17	465		10x 12	18.0	5.6	11.8	9	1	x	
18	584		10 x 8	23.5	7.3	15.4		2		
19	1026		10 x 6	4.5	1.9	3.2	10	1		x
20	977		10 x 6	5.0	1.6	3.3		2		
21	1216		3 x 6	4.7	4.5	4.6	11	1		x
22	1216		60 x 60	47.7	60.0	53.8		2		
23	1600		6 x 6	5.3	25.0	15.1	12	1		x
24	1775		6 x 6	5.1	15.0	10.1		2		

AE-C Solar Extreme Ultraviolet Spectrophotometer Instrumental Parameters

EXPERIMENT CATEGORY: Atmospheric Composition

DATE OF LAUNCH: November, 1973

INSTRUMENT NAME: Ultraviolet Spectrometer

SPACECRAFT: AE-C

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: C.A. Barth, University of Colorado

INSTRUMENT CONTRACTOR:

PURPOSE: To measure the radiation from the upper atmosphere at 2150 A and 2190 A to determine the distribution of nitric oxide in the Earth's atmosphere as a function of altitude, location and time. The intensity, as a function of observing angle will be related to the density as a function of height through the generalized chapman function.

DESCRIPTION: This instrument consists of a fixed grating spectrometer, a telescope, and a single photomultiplier tube with its associated high voltage supply, amplifiers, and logic circuits. The spectrometer is an Ebert monochromator. The telescope focuses light from the layered atmosphere on the entrance slit of the monochromator. The light emerges from the monochromator at two exit slits behind which is a single photomultiplier tube with a cesium telluride photocathode and a lithium flouride window. An optical shutter selects which of the two wavelengths is measured. The experiment package is mounted in the spinning section of the satellite so as to scan the atmosphere ahead and below the satellite. The ultraviolet emission of the atmosphere will be measured in two wavelength channels. One channel will measure nitric oxide fluorescent scattering in the (1,0) gamma band at 2150 Å and will also measure a contribution due to Rayleigh scattering of sunlight by the atmosphere when viewing below 110 km. The other channel will measure Rayleigh scattering at 2190 Å. The two channels will be measured alternately as a function of time and consequently viewing angle of the satellite. The telescope mirror is a spherical fuzed quartz mirror of 125 cm focal length.

PARAMETER SUMMARY:

Dimensions:	
Weight:	7.0 kg (15.5 lbs)
Power:	4 W
Range:	2150 A 2190 A
Field of View:	0° 15' x 4° 39'

SOURCE:

Data:	NSSDC AIM Printout (2 October, 1972), ID No. AE-C-13.
Reference:	Goddard Space Flight Center, Brief Descriptions of Atmosphere Explorer C, D & E Experiments, September, 1972.

EXPERIMENT CATEGORY:	Atmospheric Composition
DATE OF LAUNCH:	November, 1973
INSTRUMENT NAME:	Visible Airglow Photometer
SPACECRAFT:	AE-C
DESTINATION:	Earth Orbit
PRINCIPAL INVESTIGATOR:	P.B. Hays, University of Michigan
INSTRUMENT CONTRACTOR:	

PURPOSE: To provide volume emission rates for several optical emission features. In addition to the "in-situ" determination, the photometers have a remote sensing capability which is of great use in locating anomalies and temporal variation of photochemical processes observed along the satellite track.

DESCRIPTION: The instrument is a basic photometer containing two separate optical channels. Spectral selection is accomplished with a common filterwheel which contains six interference filters, a dark and calibrate position. Any one of eight possible combinations of filters can be selected for the two optical channels. Angular resolution of the two channels is determined with quartz objective optics and field defining stops. The two channels are separated in angle by 90° with one channel having a large field of view (3° half angle cone) for high sensitivity normally pointing toward the local zenith and a second channel having a small field of view 3/4° half angle cone) for high spatial resolution pointing tangent to the surface of the Earth when the satellite is in the oriented mode. Both channels are protected from stray light contamination during the daytime by multi-stage baffle systems.

PARAMETER SUMMARY:

Dimensions:

Weight: 8.8 kg (19.5 lbs)

Power:

Filters:	3371 A - N_2 second positive (0-0) band and O_2 Hertzberg I (3-5)
	4278 A - N_2^+ first negative (0-1) band
	5200 A - N (^4S) - N (^2D)
	5577 A - O (^1D) - O (^1S) atomic oxygen green line
	6300 A - O (^3P) - O (^1D) atomic oxygen red line
	7319 A - 30 A - O^+ (^2D) - O^+ (^2P)

SOURCE:

Data: NSSDC AIM Printout (2 October 1972), ID No. AE-C-14.

Reference: Goddard Space Flight Center, Brief Descriptions of Atmosphere Explorer C, D & E Experiments, September, 1972.

EXPERIMENT CATEGORY: Magnetic Field

DATE OF LAUNCH: November, 1973

INSTRUMENT NAME: Magnetometer

SPACECRAFT: AE-C

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: J.C. Armstrong, Applied Physics Lab, John Hopkins Univ.

INSTRUMENT CONTRACTOR:

PURPOSE: To measure magnetic fields due to field-aligned currents in the auroral oval simultaneously with energetic (500 eV $<$ E P keV) electrons and protons; low energy ($2 \leq E_e \leq 500$ eV) electrons; thermal electron densities and temperatures; ion densities, temperatures, drifts due to traverse electric fields and net flows along auroral field lines; and neutral temperature and density variations produced by Joule heating.

DESCRIPTION: This instrument is a vector three-axis magnetometer with resolution of approximately 5 y.

PARAMETER SUMMARY:

Dimensions:

Weight: 1.3 kg (2.8 lbs)

Power:

Range:

Resolution: Approximately 5 y (1 y = 10^{-5} Gauss)

SOURCE:

Data: Goddard Space Flight Center, Brief Descriptions of Atmosphere Explorer C, D & E Experiments, September, 1972.

Reference: Same as above.

EXPERIMENT CATEGORY: Ultraviolet

DATE OF LAUNCH: November, 1973

INSTRUMENT NAME: Extreme Solar Ultraviolet Monitor

SPACECRAFT: AE-C

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: D.F. Heath, NASA/GSFC

INSTRUMENT CONTRACTOR: Ball Brothers Research, Boulder, Colorado

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PURPOSE: To measure the extreme ultraviolet solar irradiance in the 40-1220 Å region and to investigate the nature of the variability of the sun as a star in this wavelength region over the lifetime of the satellite.

DESCRIPTION: This instrument consists of two principal components which are a detector head with its associated electronics and a main electronics section. It is located on the -Y axis and with the detectors oriented at an angle of 65° to the +Z axis along a radius of the wheel. The field of view is a 30° half cone angle symmetric about the 65° angle to the +Z axis. The detectors consist of four channeltron electron multipliers (Bendix Spiraltrons) located behind an 8-position stepped filter wheel. The filter wheel contains 6 metallic filters with transmission bands in the 40-1100 Å region, and Fe^{55}, beta particle calibration source and a blank position to provide a zero light signal level. A visible light diode is also located behind the filter wheel in one of the detector positions to monitor the filter integrity and pinhole transmission throughout the course of the mission. Three windowless diodes with Al_2O_3 photocathodes are positioned beyond the edge of the filter wheel. Two of the photodiodes have fixed filters in front of the photocathode. A filter protection mask serves both to protect the filters during the launch and low perigee phases as well as to further reduce the level of scattered light reaching the detectors.

PARAMETER SUMMARY:

Dimensions:

Weight: 7.3 kg (16.0 lbs)

Power:

Range:

SOURCE:

Data: NSSDC AIM Printout (2 October 1972), ID No. AE-C-05.

Reference: Goddard Space Flight Center, Brief Descriptions of Atmosphere Explorer C, D & E Experiments, September, 1972.

	Filter	Detector	50% Signal Interval
1.	Aluminum + Parylene	Channel	45-65A
2.	Aluminum + Carbon	Channel	240-303A
3.	Aluminum	Channel, Diode	270-550A
4.	Titanium	Channel	365-535A
5.	Tin	Channel	570-584A
6.	Indium	Channel, Diode	800-935A
7.	No filter	Diode	1216A

AE-C Extreme Solar Ultraviolet Monitor Instrumental Parameters

EXPERIMENT CATEGORY:	Visible and Infrared
DATE OF LAUNCH:	November, 1973
INSTRUMENT NAME:	Multispectral Scanner Subsystem (MSS)
SPACECRAFT:	ERTS-B
DESTINATION:	Circular Polar Orbit
PRINCIPAL INVESTIGATOR:	Data Processing Branch Staff, Goddard Space Flight Center
INSTRUMENT CONTRACTOR:	Hughes Aircraft Company, Culver City

PURPOSE: To provide repetitive day/night acquisition of high-resolution multispectral data of the Earth's surface on a global basis. To obtain information in various areas such as agriculture, forestry, geology and hydrology. The system can also be used for oceanographic and meteorological purposes.

DESCRIPTION: The experiment consists of a 22.86 cm double reflector-type telescope, scanning mirror, filters, detectors, and associated electronics. The scanner operates in the following spectral intervals - Band 1 is 0.5 to 0.6 microns, Band 2 is 0.6 to 0.7 microns, Band 3 is 0.7 to 0.8 microns, Band 4 is 0.8 to 1.1 microns, and Band 5 is 10.4 to 12.6 microns. This last band, which lies in the thermal (emissive) part of the spectrum, gives ERTS-B night-time sensing capabilities. Incoming radiation is collected by the scanning mirror, which oscillates 2.89° to either side of the nadir and scans cross-track swaths 185 km wide. The along-track scan is produced by the orbital motion of the spacecraft. The primary image produced at the image plane is relayed by use of fiber optic bundles to detectors where conversion to an electronic signal is accomplished. During scan retrace, a rotating shutter blanks out the scene and sweeps a calibration lamp across all fibers so that onboard radiometric levels may be maintained accurately. The sun is flashed across the fiber ends once per orbit so that the calibration light may be checked. Optical filters are used to produce the desired spectral separation. Six detectors are employed in each of the first four spectral bands and two in the fifth band. Bands 1 through 3 use photomultiplier tubes as detectors, Band 4 uses silicon photodiodes, and Band 5 uses mercury-cadmium-telluride detectors. A multiplexer included in the MSS system processes the scanner's 26 channels of data. These data are time-multiplexed and then converted to a pulse-code-modulated (PCM) signal by an A/D converter. The data are then transmitted (2229.5 MHz) directly to an acquisition or stored on magnetic tape for subsequent playback the next time the spacecraft comes within communication range of an acquisition station.

PARAMETER SUMMARY:

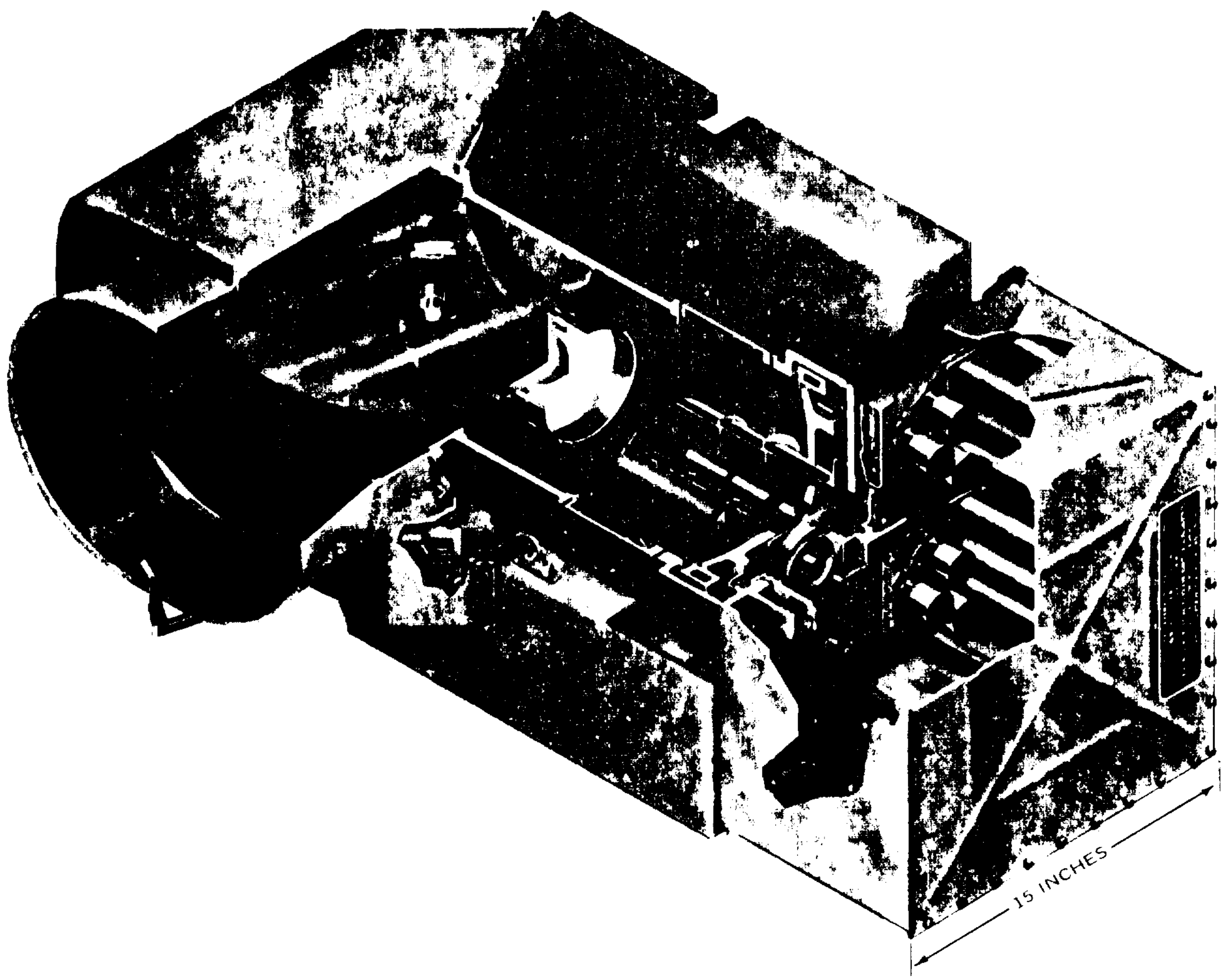
Dimensions:	Scanner - 86.4 x 38.1 x 38.1 cm (34.0 x 15.0 x 15.0 in.) Multiplexer - 16.5 cm (6.5 in.) x
Weight:	54.5 kg (120.0 lbs)
Power:	65 W
Sensor Resolution:	0.1 km
Scan Method:	Oscillating mirror - 34.8 x 22.9 cm (13.7 x 9.0 in.)
Optics:	22.9 cm (9.0 in.) Richey-Chretien with 10.2 cm (4.0 in.) secondary f/3.6
Spectral Bands:	Band 1 - 0.5 to 0.6 microns; 6 photomultiplier tubes Band 2 - 0.6 to 0.7 microns; 6 photomultiplier tubes Band 3 - 0.7 to 0.8 microns; 6 photomultiplier tubes Band 4 - 0.8 to 1.1 microns; 6 silicon photodiodes Band 5 - 10.4 to 12.6 microns; 6 mercury-cadmium-telluride detectors
Instantaneous Field of View:	86 microradians in Bands 1, 2, 3 and 4
Limiting Resolution:	3,048 cm (100 ft)
Operational Resolution:	6,858 cm (225 ft)
Signal-to-Noise Ratio:	Band 1 - S/N = 112 at 2.5 mw cm^{-2} $ster^{-1}$ Band 2 - S/N = 86 at 2.0 mw cm^{-2} $ster^{-1}$ Band 3 - S/N = 72 at 1.8 mw cm^{-2} $ster^{-1}$ Band 4 - S/N = 122 at 4.6 mw cm^{-2} $ster^{-1}$
Band to Band Registration:	Better than 1,524 cm (50 ft)
Line to Line Scan Precision:	Better than 609.6 cm (20.0 ft)

Calibration Method: Internal incandescent lamp - six times/sec, sunlight one time each orbit

SOURCE:

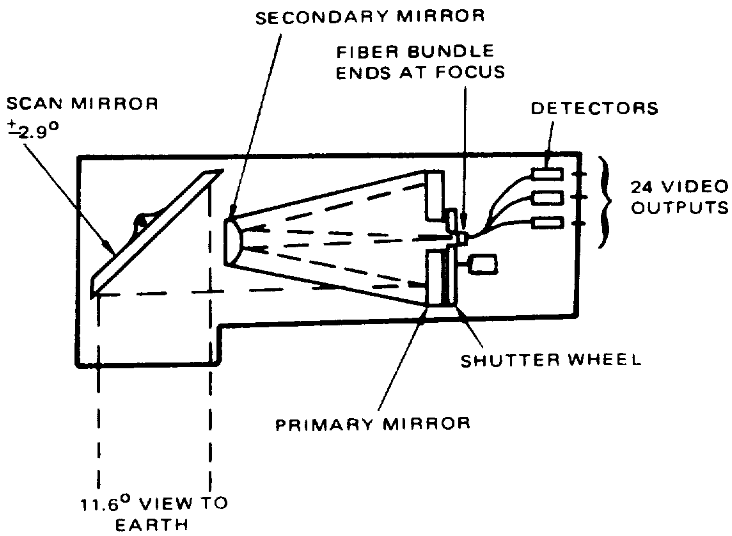
Data: Hughes Aircraft Company, "Hughes Multispectral Scanner System for ERTS - Goddard Space Flight Center", SCG 20412B.
NSSDC AIM Printout (2 October 1972), ID No. ERTS-B-02.

Reference:

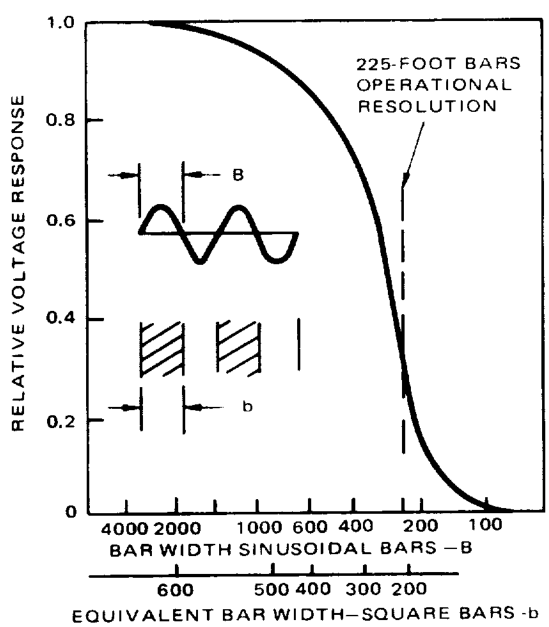


ERTS-B Multispectral Scanner Subsystem

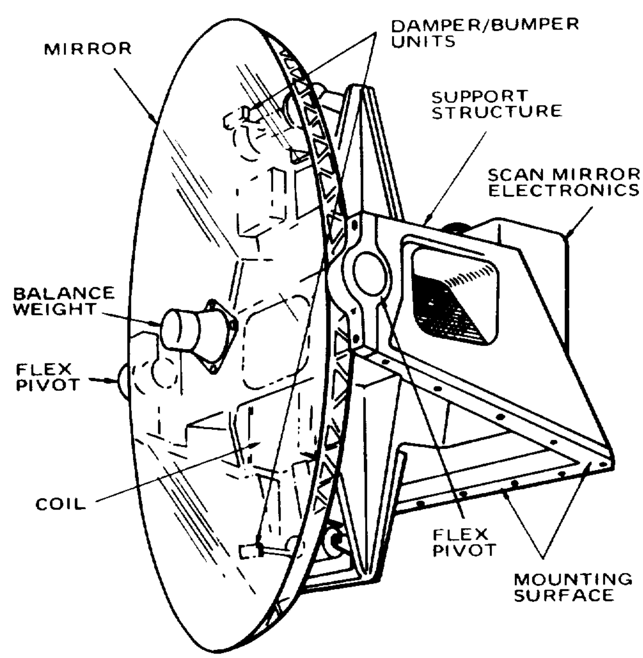
FOUR-BAND SCANNER CONFIGURATION



MODULATION TRANSFER FUNCTION



SCAN MIRROR ASSEMBLY



ERTS-B Multispectral Scanner Subsystem

EXPERIMENT CATEGORY:	Visible Frequency, Cameras
DATE OF LAUNCH:	November, 1973
INSTRUMENT NAME:	Return Beam Vidicon (RBV) Camera System
SPACECRAFT:	ERTS-B
DESTINATION:	Circular Polar Orbit
PRINCIPAL INVESTIGATOR:	O. Weinstein, Goddard Space Flight Center
INSTRUMENT CONTRACTOR:	RCA Astro-Electronics Division, Princeton, N.J.

PURPOSE: To obtain earth resource type studies. To conduct meteorological studies, to investigate atmospheric attenuation, and to observe mesoscale phenomena, winter monsoon clouds, and snow cover.

DESCRIPTION: The return beam vidicon camera system contains three independent cameras covering the three spectral bands from blue-green (0.47 to 0.57 microns) through yellow-red (0.58 to 0.68 microns) to near infrared (0.69 to 0.83 microns). The three earth-oriented cameras are mounted to a common base, which is structurally isolated from the spacecraft to maintain accurate alignment. Each camera contains an optical lens, a 5.08 cm return beam vidicon, a thermoelectric cooler deflection and focus coils, a mechanical shutter, erase lamps, and sensor electronics. The cameras are similar except for the spectral filters contained in the lens assemblies that provide separate spectral viewing regions. The viewed ground scene, 185 x 185 km in area, is stored on the photosensitive surface of the camera tube, and after shuttering the image is scanned by an electron beam to produce a video signal output. Each camera is read out sequentially, requiring about 3.5 sec for each of the spectral images. The cameras are reshuttered every 25 sec to produce overlapping images along the direction of spacecraft motion. Video data from the RBV is transmitted (2265.4 MHz) in both real-time and tape recorder modes. From a nominal spacecraft altitude of 912 km, the RBV has a horizontal resolution of about 0.7 km.

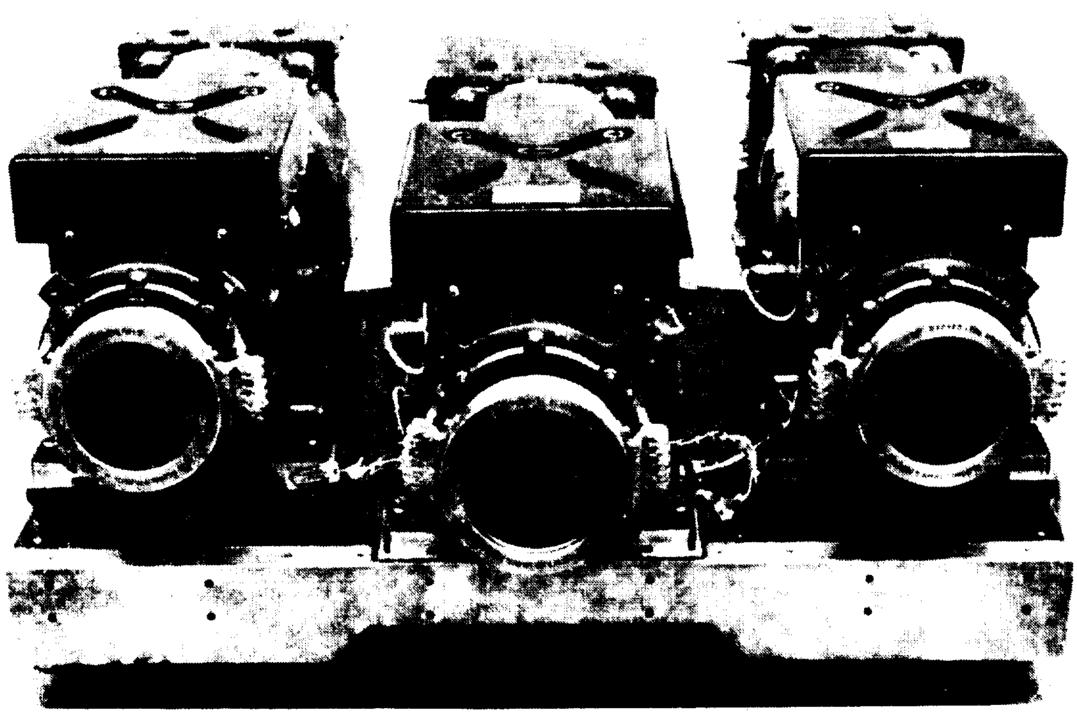
PARAMETER SUMMARY:

Dimensions:	Base Plate With Sensors - 64.8 x 67.8 x 31.5 cm (25.5 x 26.7 x 12.4 in.) Electronics - 4 boxes each 15.2 x 15.2 x 33.0 cm (6.0 x 6.0 x 13.0 in.)
Total Weight:	89.0 kg (196.0 lbs)
Power:	172 W
Range:	Blue-Green (0.47 to 0.57 microns) Yellow-Red (0.58 to 0.68 microns) Near infrared (0.69 to 0.83 microns)
Earth Scanning Lenses:	Focal Length - 12.60 cm (4.96 in.) Relative Aperture - f/2.9 (T/3.2) Relative Illumination - 85% Transmission - 80% MTF - 55% at 100 lp/mm Image Format - 2.54 x 2.54 cm (1.00 x 1.00 in.) Distortion - 30 micrometers Barrel Materials - Titanium (all material in lens required to be non-magnetic) Weight - 2.3 kg (5.0 lbs)
Sensor Resolution:	0.1 km
Field of View:	15.9°
Deflection and Focus:	Electromagnetic
Resolution:	4500 TV lines
Dynamic Range:	30 to 1
Highlight Brightness:	Channels 1 and 2 - 0.78 micron J/cm^2 Channel 3 - 1.2 micron J/cm^2
Residual Image:	Less than 1%
Video Bandwidth:	3.2 MHz
Exposure Time:	8, 12, 16 milliseconds (selectable)
Three-camera Cycle Rate:	25 seconds

Frame Time:	3.5 seconds
Peak Signal/rms Noise:	33 dB
Active Horizontal Scan Lines:	4125

SOURCE:

Data:	Fairchild Camera and Instrument Corporation, Space and Defense Systems Division, "Fairchild Lenses ... Scanning the Earth's Natural Resources," no date. NSSDC AIM Printout (2 October 1972), ID No. ERTS-B-01. RCA, ERTS Return-Beam Vidicon Camera System, G&CS/SCN 204-71.
Reference:	O. Weinstein, Goddard Space Flight Center



ERTS-B Return Beam Vidicon Camera System

EXPERIMENT CATEGORY: X-Ray

DATE OF LAUNCH: December, 1973

INSTRUMENT NAME: 0.3 - 30 keV Rotation Columator

SPACECRAFT: UK-5

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: R.L.F. Boyd, MSSL University College London

INSTRUMENT CONTRACTOR:

PURPOSE: To measure source positions and conduct a sky survey of X-ray sources in the energy range of 0.3 to 30 keV.

DESCRIPTION: This instrument combines the functions of X-ray instruments in two different energy ranges with that of star tracking. In effect, the package contains three independent detectors with little electrical interconnection but the channel multipliers and photomultipliers observe parts of the same field of view. The collimator consists of parallel grids of goldcoated etched stainless steel having an area of the order of 929 cm^2 (1 ft^2). The grids are mounted parallel to one another, normal to the spin axis and separated by about 2.54 cm (1.0 in.). The collimator is limited to an acceptance angle of 35° FWHM, centered about the spin axis, by an egg crate collimator placed between the two gratings. The three sensors are mounted behind the collimator. Visible stars are detected by a 2 cm diameter photomultiplier with circuitry to count the individual photons received. X-rays of energy in the region 2.5 to 30 keV are detected by an array of beryllium walled proportional counter tubes. Rejection of charged particle background is achieved by using a pulse rise time discriminator in an anticoincidence system. The output pulses due to X-rays are processed by a pulse height analyzer into three channels. X-rays of still lower energy are detected by an array of funnel cathode channel electron multiplier tubes with total sensitive area 10 cm^2. The energy regions to which this array is sensitive is determined by matched filters brought into place by ground command.

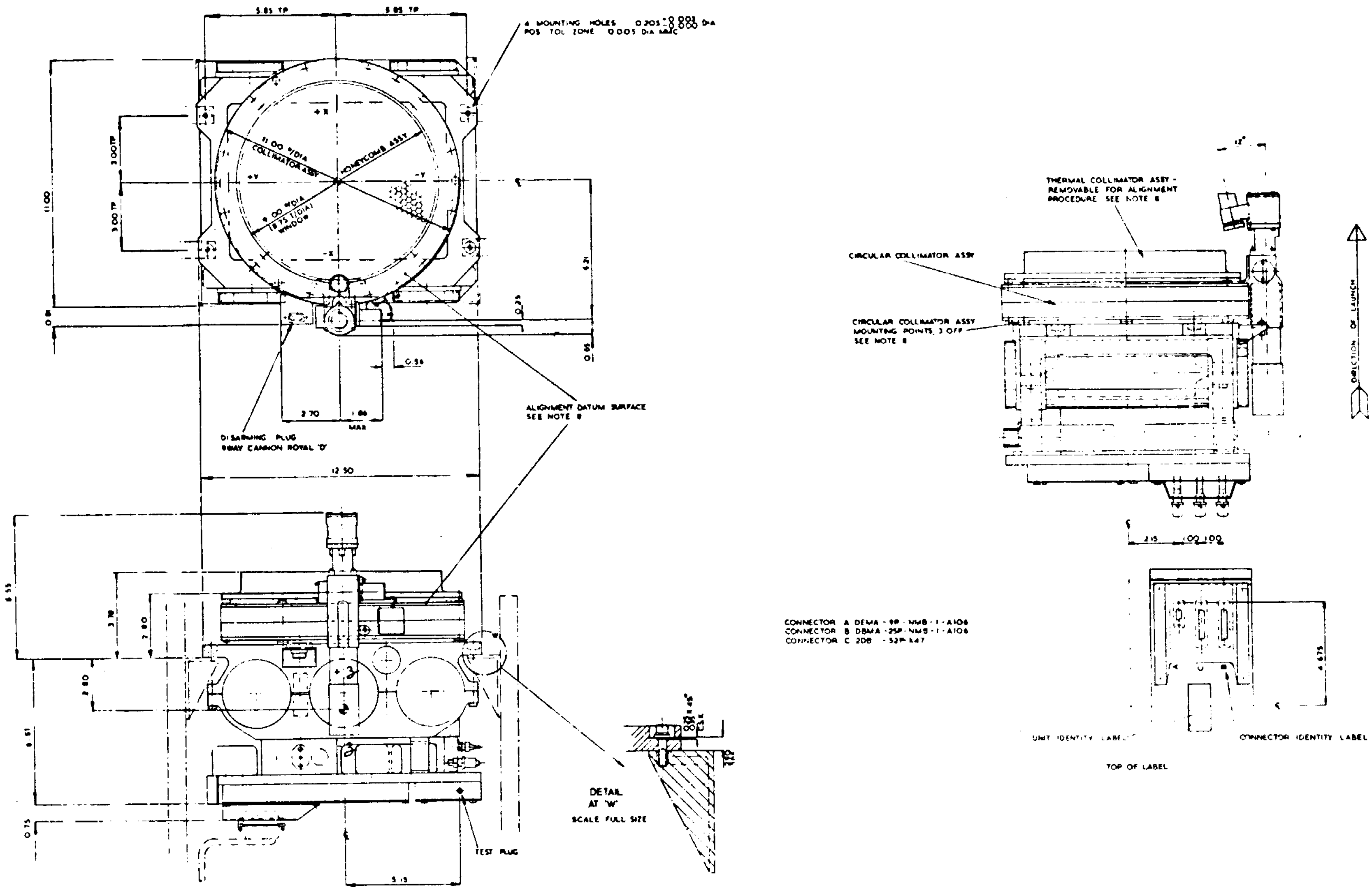
PARAMETER SUMMARY:

Dimensions:	31.7 x 27.9 x 22.8 cm (12.5 x 11.0 x 9.0 in.)
Weight:	7.3 kg (16.0 lbs)
Power:	
Range:	0.3 - 30 keV
FOV:	Cone with semi-angle of 10° to 20°
Acceptance Angle:	35° FWHM
Total Sensitive Area:	10 cm^2

SOURCE:

Data: Goddard Space Flight Center, Project Plan for United Kingdom Research Satellite (UK-5), 7 November 1972.
NSSDC AIM Printout (2 October 1972), ID No. UK-5-01.

Reference: Science Research Council, Proposed Payload for UK-5 Satellite - A Cosmic X-Ray Satellite, March, 1970 (London) p. 6-10.



UK-5 0.3 - 30 keV Rotation Columator

EXPERIMENT CATEGORY: X-Ray

DATE OF LAUNCH: December, 1973

INSTRUMENT NAME: 1.5-20 keV Sky Survey

SPACECRAFT: UK-5

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: K.A. Pounds, University of Leicester

INSTRUMENT CONTRACTOR:

PURPOSE: This instrument will conduct a sky survey in the energy range 1.5 to 20 keV.

DESCRIPTION: The instrument is a large area proportional counter arranged to view in a direction perpendicular to the satellite spin axis. The satellite rotation, therefore, allows a scan of a 360° band of the sky. If the satellite spin axis is arranged to point at a galactic pole the whole of the Milky Way may be scanned at once. The instrument covers the photon energy range 1.5 to 20 keV and effects a high sensitivity survey obtaining source locations, intensity, and spectra. A number of different modes of operation will be used in which the available storage space in the core store is used to obtain spatial information at the expense of spectral resolution or conversely. The sensitivity of the instrument will allow the detection of sources of the order of 10^{-4} times the intensity of Sco XR-1 within the time of about one day. The ability of the survey instruments to determine the positions of source depends on the strength of the source and the number of other sources in a given part of the sky. A source of 5×10^{-3} times the strength of Sco XR-1 can be located with a precision of about 15 arc minutes.

PARAMETER SUMMARY:

Dimensions: 20.3 x 34.9 x 35.6 cm (8.0 x 13.7 x 14.0 in.)

Weight: 8.8 kg (19.4 lbs)

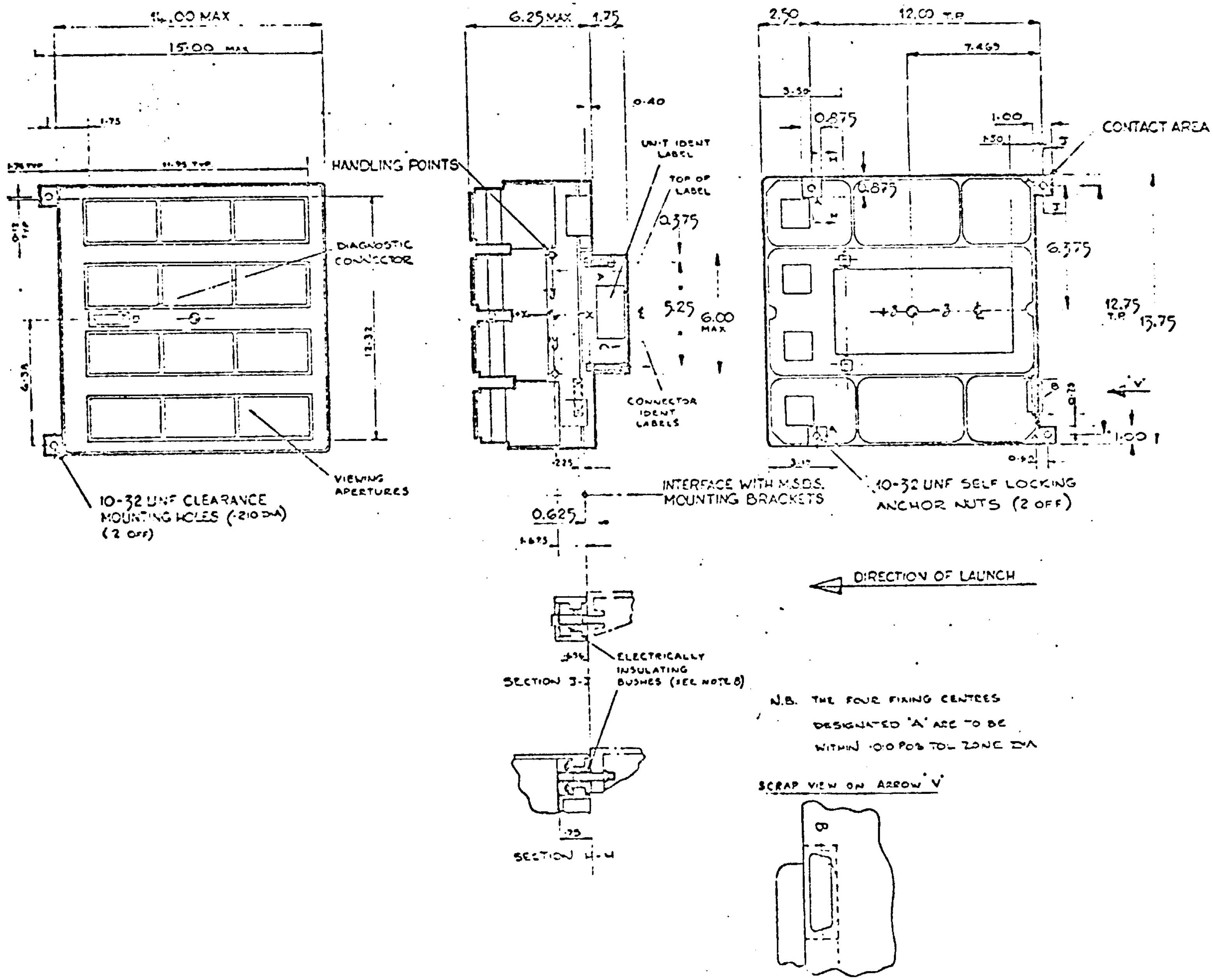
Power: 0.43 W

Range: 1.5 to 20 keV

Temperature Extremes:	-10° to + 40° C
Alignment:	About ZZ and YY axes to within ± 10 arc mins by shimming under unit mounting feet. XX axis (spin axis) alignment is nonadjustable - will be better than ± 19 arc mins.
Field Collimators:	½° x 5° 2° x 15°
Array of Area:	Approximately 1300 cm^2
Photon Sensitivity:	5 x 10^{-3} photons cm^{-2} sec^{-1}

SOURCE:

Data:	Goddard Space Flight Center, Project Plan for United Kingdom Research Satellite (UK-5), 7 November 1972. NSSDC AIM Printout (2 October 1972), ID No. UK-5-02.
Reference:	K.A. Pounds, Department of Physics, University of Leicester.



UK-5 1.5-20 keV Rotation Columator

EXPERIMENT CATEGORY: X-Ray

DATE OF LAUNCH: December, 1973

INSTRUMENT NAME: 2-30 keV Source Spectra

SPACECRAFT: UK-5

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: J.C. Ives, MSSL University College London

INSTRUMENT CONTRACTOR:

PURPOSE: To make a pointed study of the spectra of individual sources in the 2 to 30 keV energy range.

DESCRIPTION: The instrument consists of a proportional counter, a honeycomb collimator and associated electronics. The proportional counter has a square window of 100 micron beryllium with an effective area of 100 sq cm. The counter is filled with a xenon-carbon dioxide gas mixture. The collimator defines the field of view at 3½ by 3½° FWHM. The detector will view in a direction parallel to the spin axis and therefore continue to observe the same piece of sky for as long as the position of the spacecraft spin axis remains unaltered. The instrument axis is pointed approximately 2° off the spin axis. There are 128 storage locations in the core store. Particle background rejection is achieved by a sophisticated anticoincidence system, as opposed to pulse shape discrimination. To achieve this, the detector volume is divided into a large number of independent proportional counter cells and these are then connected so that each cell is operated in anti-coincidence with all of its neighboring cells. The calibration is done by irradiating the counter with an Fe^{55} K capture source.

PARAMETER SUMMARY:

Dimensions: 24.6 x 17.8 x 22.9 cm (9.7 x 7.0 x 9.0 in.)

Weight: 3.9 kg (8.5 lbs)

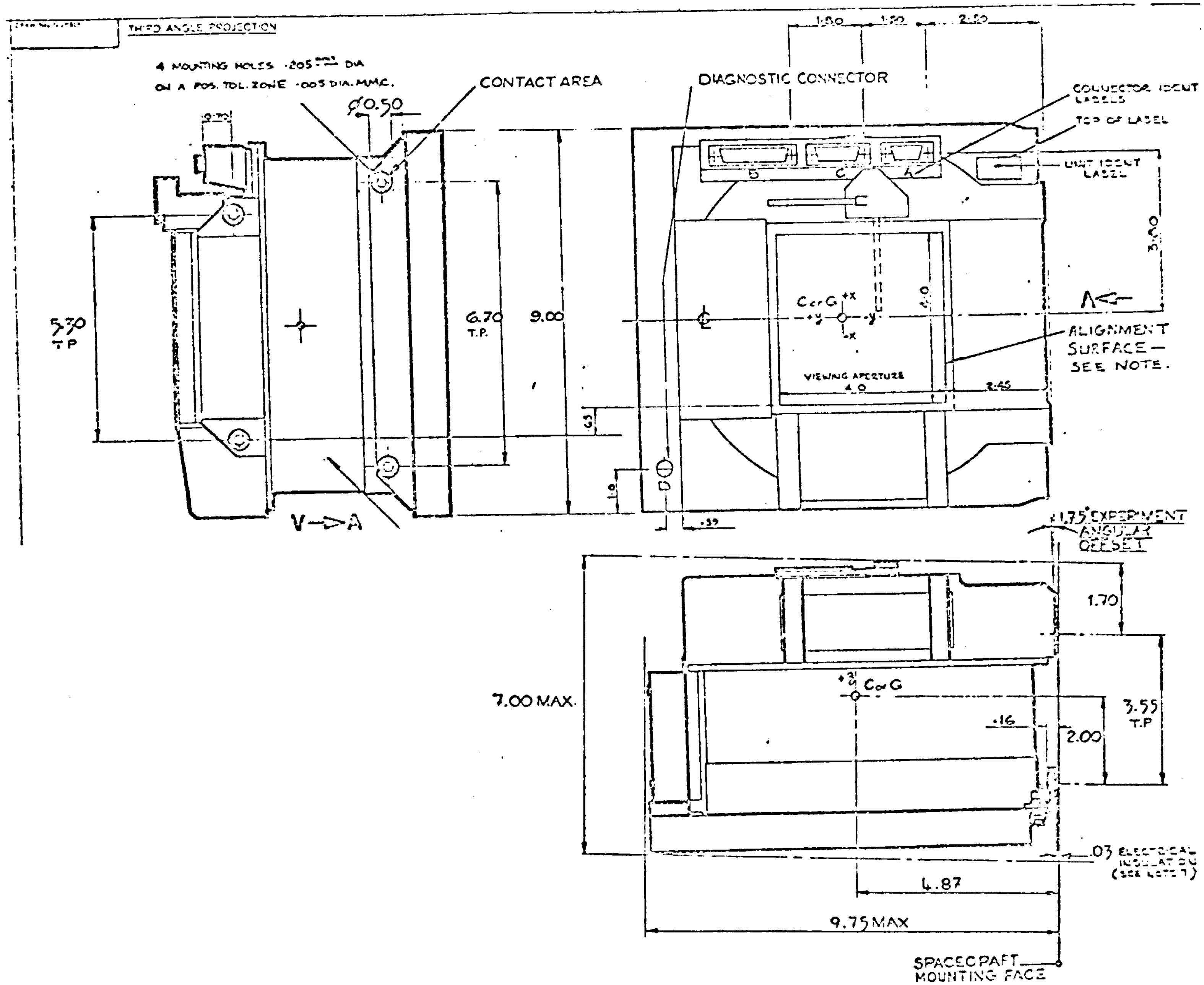
Power:

Range: 2-30 keV

SOURCE:

Data: Goddard Space Flight Center, Project Plan for United Kingdom Research Satellite (UK-5), 7 November 1972.
NSSDC AIM Printout (2 October 1972), ID No. UK-5-03.

Reference: Science Research Council, Proposed Payload for UK-5 Satellite - A Cosmic X-Ray Satellite, March, 1970 (London), p. 14-16.



UK-5 2-30 keV Source Spectra

EXPERIMENT CATEGORY: X-Ray

DATE OF LAUNCH: December, 1973

INSTRUMENT NAME: All Sky Monitor

SPACECRAFT: UK-5

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: S.S. Holt, Goddard Space Flight Center

INSTRUMENT CONTRACTOR:

PURPOSE: To monitor all sky X-rays. To aid in programming satellite maneuvers such that transient events in the X-ray sky could be investigated in detail by the other primary satellite experiments.

DESCRIPTION: This is a scanning instrument which monitors the X-ray emission from the entire celestial sphere at all times thereby covering the large areas that lie outside the field of view of other on board experiments. It is a valuable aid in programming satellite maneuvers so that transient events in the X-ray sky, such as nearby novae and X-ray flares, may be rapidly made available for study, with greater resolution, by the other experiments. Over the course of a year's observations sufficient information will be available to make a low resolution relief map of the entire X-ray sky to precision of about 1% in intensity. An X-ray imaging system using a pin-hole camera and a position sensitive proportional counter at the image plane was designed for this experiment. The position sensitive proportional counter is the detector for this application. The detecting volume of P-10 gas under a 5 mil beryllium window is partitioned by wire walls into six separate proportional counters, all but one of which are operated solely as charged particle anti-coincidence elements for the positron-sensitive counter. All six anodes are 1 mil in diameter, with the positron sensitive anode having high enough resistivity to allow the electronic positron sensing techniques.

PARAMETER SUMMARY:

Dimensions: 25.4 x 25.4 x 11.4 cm (10.0 x 10.0 x 4.5 in.)

Weight: 2.5 kg (5.4 lbs)

Power: 500 mw

Range: 3 to 6 keV

Detectors: Two proportional counters; 1 resistive anode used for charge location and 5 conductive anodes; 1.25 atmospheres of P-10 gas; approximately 30 cm (11.8 in.) in length and a pinhole area of 1 cm^2 placed just high enough above the detector to achieve 90° coverage.

Sensitivity: Estimated at 0.6 cm^{-2} sec^{-1} in the energy band 3 to 6 keV, or about 3% of the intensity of Sco X-1 (the brightest X-ray source in the sky).

Position Sensitive Proportional Counter: Detector uses 1 mil quartz fiber with pyrolytically deposited graphite.

SOURCE:

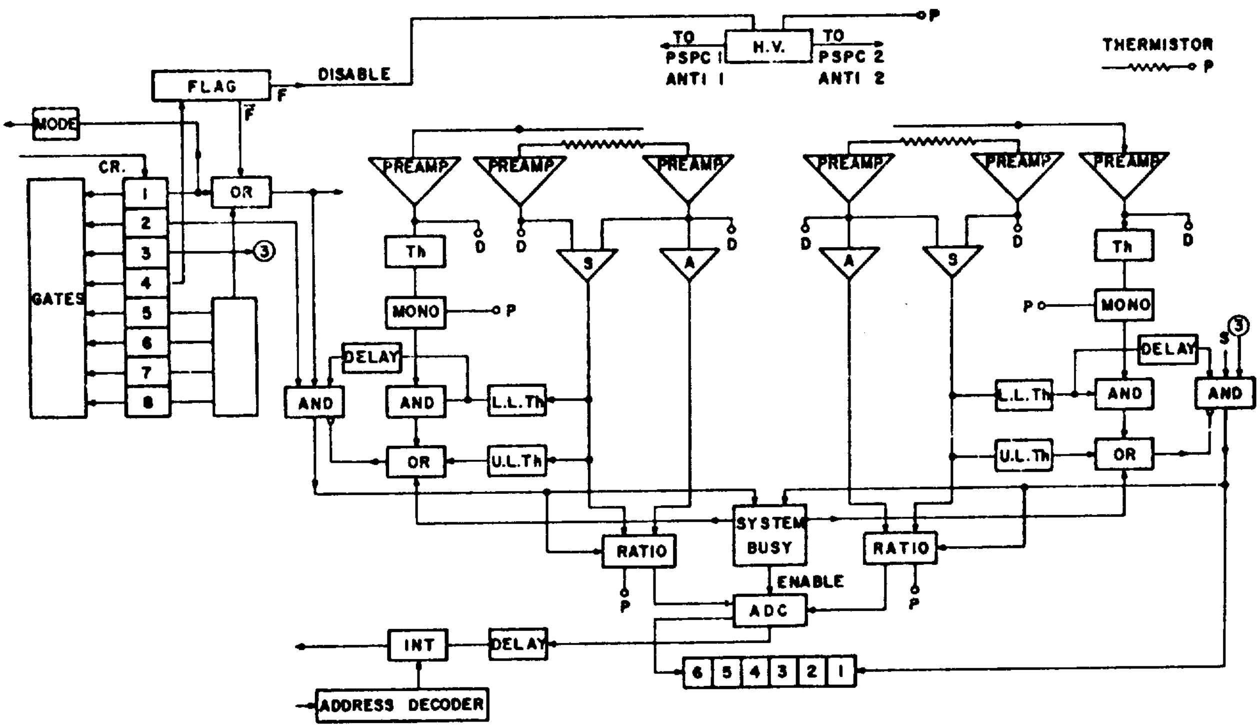
Data:

Desai, U.D. and S.S. Holt, "An All-Sky X-Ray Monitor for the UK-5 Satellite," IEEE Transactions on Nuclear Science, Vol. NS-19, No. 1, February, 1972, pp. 592-595.

Goddard Space Flight Center, Project Plan for United Kingdom Research Satellite (UK-5), 7 November 1972.

NSSDC AIM Printout (2 October 1972), ID No. UK-5-06.

Reference: Dr. S. Holt, Goddard Space Flight Center.



D – TO DIAGNOSTIC CONNECTOR
P – ANALOG OUTPUTS FOR MONITORING

BLOCK DIAGRAM

UK-5 All Sky Monitor

EXPERIMENT CATEGORY:	X-Ray
DATE OF LAUNCH:	December, 1973
INSTRUMENT NAME:	Pointed High Energy X-Rays
SPACECRAFT:	UK-5
DESTINATION:	Earth Orbit
PRINCIPAL INVESTIGATOR:	H. Elliot, Imperial College, London
INSTRUMENT CONTRACTOR:	

PURPOSE: To measure the high energy end of the X-ray spectrum.

DESCRIPTION: This instrument uses a crystal scintillator detector in a deep active anti-coincidence well. The telescope is pointed with a 3° off-set to the satellite spin axis and the resulting modulation of off-axis point sources is used as a background rejection technique. The detector and electronics packages are integrated in one unit. Measurements are possible up to 2 MeV although the efficiency of the detector falls steeply at this energy.

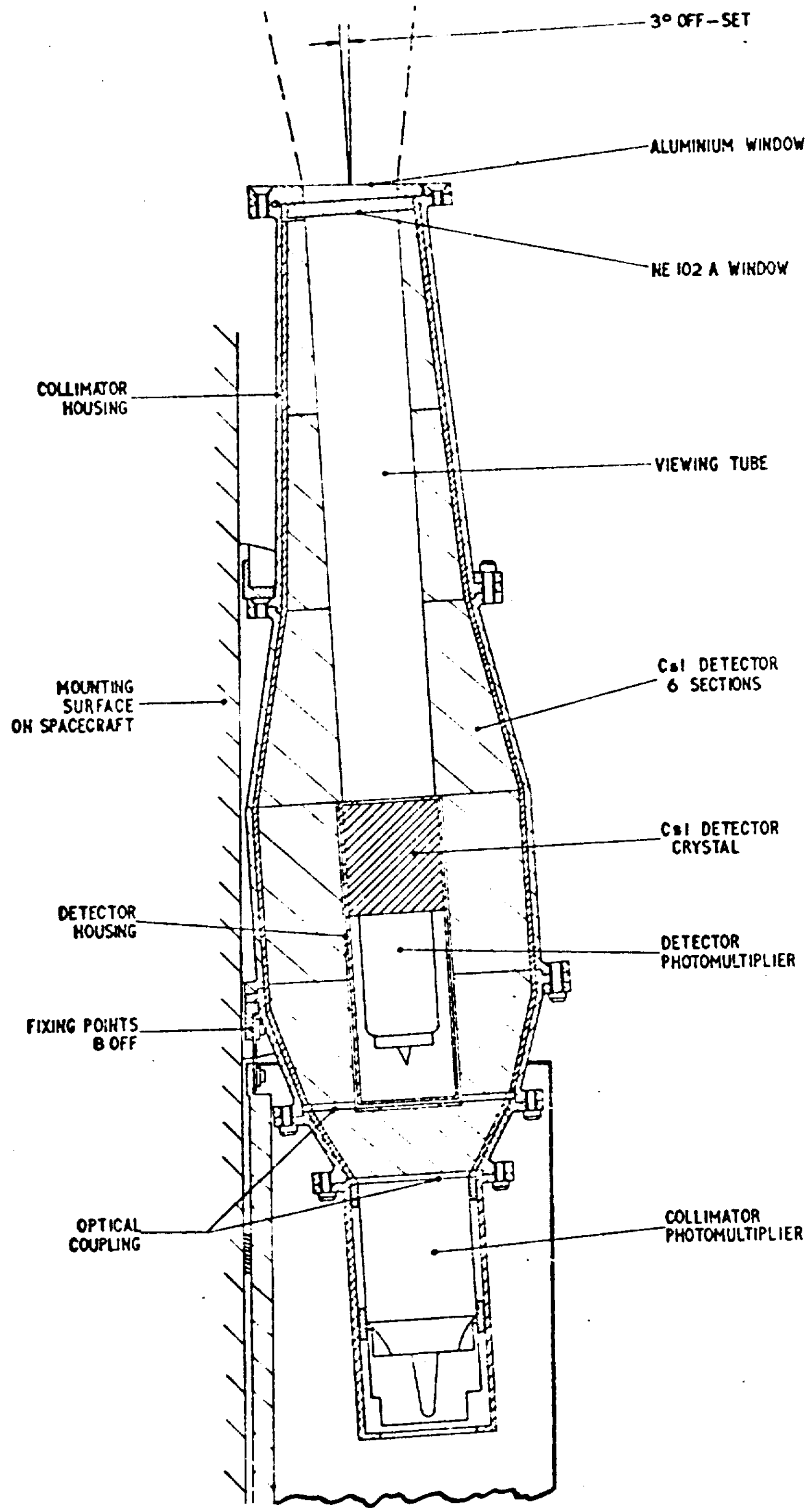
PARAMETER SUMMARY:

Dimensions:	55.9 x 11.4 x 12.7 cm (22.0 x 4.5 x 5.0 in.)
Weight:	7.9 kg (17.5 lbs)
Power:	590 mw
Range:	Up to 500 keV
Detector Crystal:	CsI (Na) 3.3 cm diam x 4 cm
Collimator:	CsI (Na) stack of 6 crystals overall length 35 cm shielded by 0.2 cm Al housing
Window:	0.01 cm (0.004 in.) Al, 0.4 cm plastic scintillator for charged particle rejection
Opening Angle:	8° FWHM, 16° FW (to zero response)
Energy Range:	30 keV to 1.5 MeV nominal (50 keV to 250 keV window for pulsar mode)

Pulse Height Analysis:	16 channels spaced logarithmically (single window for pulsar analysis mode)
Operating Modes:	(a) 4 min integration of data (b) 8 min integration of data in 4 spin quadrants (c) Pulsar analysis mode (single channel)

SOURCE:

Data:	Goddard Space Flight Center, Project Plan for United Kingdom Research Satellite (UK-5), 7 November 1972. NSSDC AIM Printout (2 October 1972), ID No. UK-5-05.
Reference:	H. Elliot, Professor of Physics, Imperial College of Science and Technology.



UK-5 Pointed High Energy X-rays

EXPERIMENT CATEGORY: X-Ray

DATE OF LAUNCH: December, 1973

INSTRUMENT NAME: Polarimeter/Spectrometer

SPACECRAFT: UK-5

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: K.A. Pounds, University of Leicester

INSTRUMENT CONTRACTOR:

PURPOSE: To measure the spectra and polarization of X-ray sources in the 2 to 8 keV energy range.

DESCRIPTION: This instrument is a Bragg crystal/spectrometer operating in the 2 to 8 keV range. It uses two large plane crystals, lithium hydride and graphite and has a honeycomb collimator. It is mounted to view along the satellite spin axis and examines the radiation of individual X-ray sources for possible polarization and/or the existence of line emissions. In a source of brightness of the Crab Nebula, a polarization of 2.5 % can be detected. The instrument also conducts searches for pulsar activity. The nature of the experiment makes it possible to examine the polarization of the pulsar itself by looking for different pulsar behavior in the separate polarization components.

PARAMETER SUMMARY:

Dimensions: 23.5 x 34.3 x 35.6 cm (9.2 x 13.5 x 14.0 in.)

Weight: 10.0 kg (22.0 lbs)

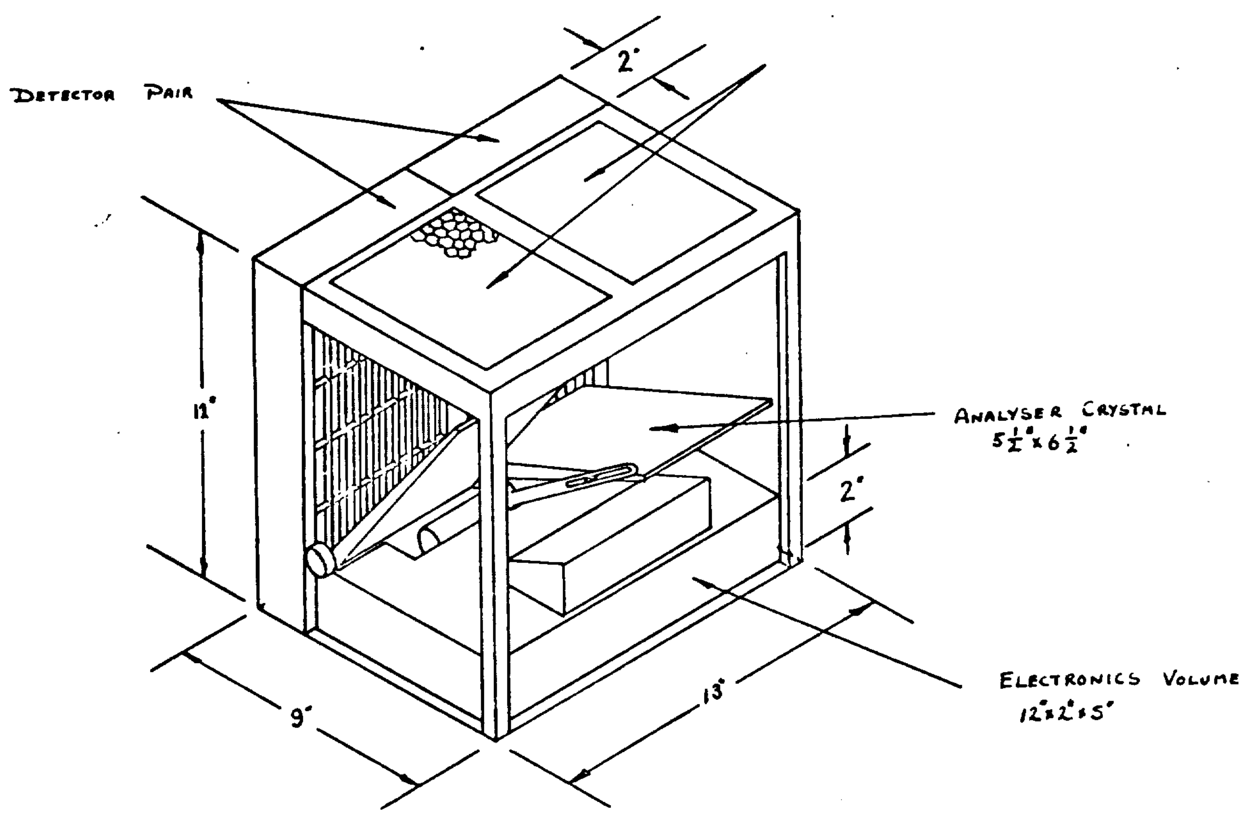
Power: 0.4 W

Range: 2 to 8 keV

Temperature Extremes: -10° to + 40° C

Alignment: About XX axis to within ± 10 arc mins by shimming under mounting feet. About ZZ and YY axes alignment nonadjustable. Will be better than ± 15 arc mins about YY axis and better than ± 1° about ZZ axis.

Bragg Angle:	45°
SOURCE:	
Data:	Goddard Space Flight Center, Project Plan for United Kingdom Research Satellite (UK-5), 7 November 1972. NSSDC AIM Printout (2 October 1972), ID No. UK-5-04.
Reference:	K.A. Pounds, Department of Physics, University of Leicester.



UK-5 Polarimeter/Spectrometer

EXPERIMENT CATEGORY:	Visible and Infrared Radiometry
DATE OF LAUNCH:	January, 1974
INSTRUMENT NAME:	Visible and Infrared Spin Scan Radiometer (VISSR)
SPACECRAFT:	SMS-A
DESTINATION:	Earth Geosynchronous Orbit
PRINCIPAL INVESTIGATOR:	D.V. Fordyce, Goddard Space Flight Center
INSTRUMENT CONTRACTOR:	Santa Barbara Research Center

PURPOSE: To provide high resolution spin scan pictures of the Earth in two spectral regions (0.55 to 0.70 microns and 10.5 to 12.6 microns) for mapping the Earth and clouds for meteorological purposes. The instrument will provide day and night mapping capability with a satellite subpoint resolution of 0.9 km in daylight and 9.3 km at night.

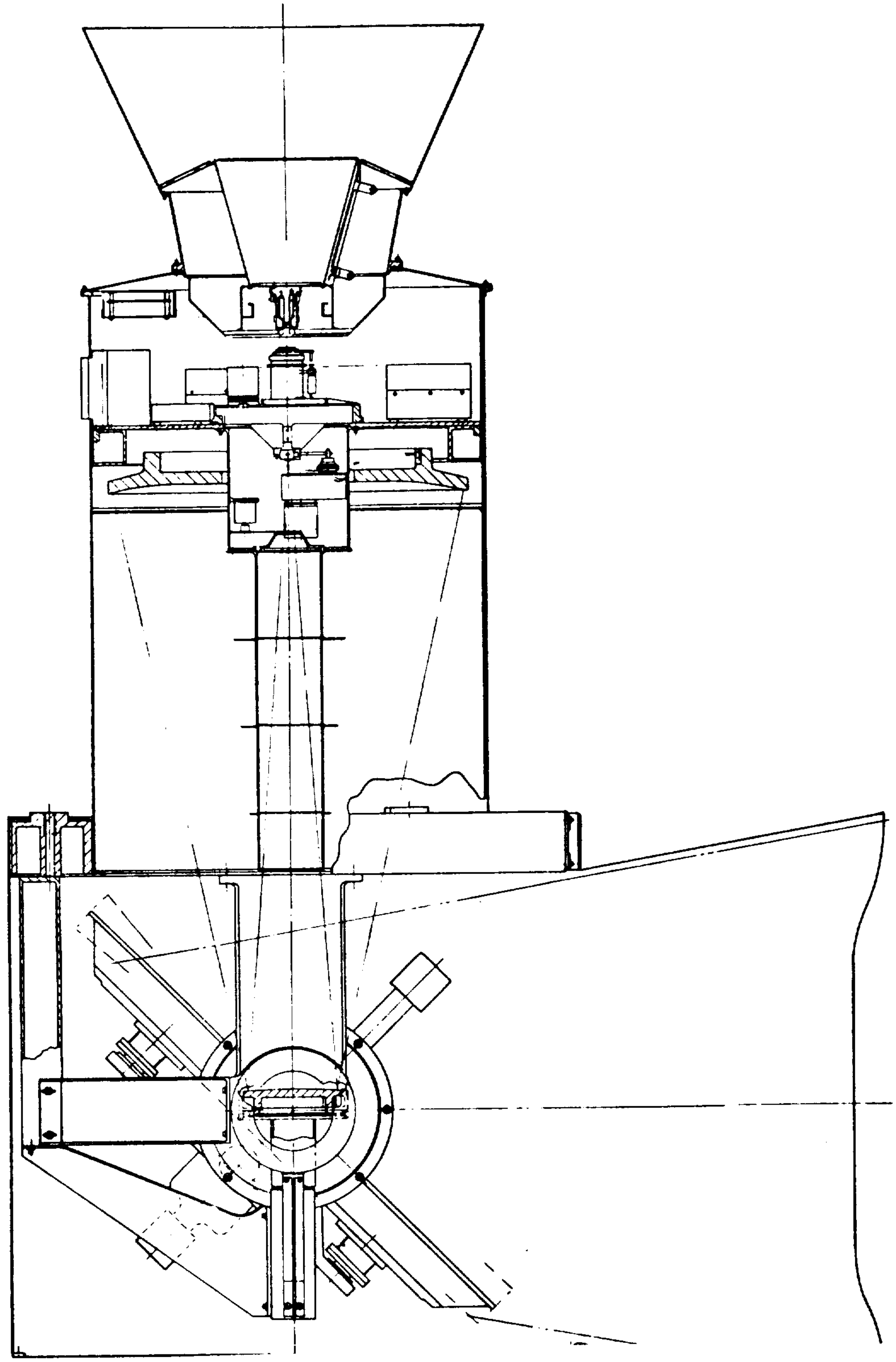
DESCRIPTION: The scanner design uses a plane scan mirror and primary optics which are common to the visible and thermal channels. The scan mirror is set at an angle to the radiometer telescope (primary optics) axis which is aligned parallel to the spin axis of the spacecraft. The spinning motion of the spacecraft, therefore, provides an east-west line scan motion when the spin axis of the spacecraft is oriented parallel with the Earth's axis. Radiation collected by the primary optics is imaged in a plane between the primary and secondary mirrors. At this point, the visible and thermal channels are optically separated. Fiber optics light-guides are the defining field stop aperture for the eight visible channels. Radiation intercepted by each of the fiber optic light-guides is collimated by a spherical lens and then filtered. Following filtering, the collimated radiation in each visible channel is directed into a photomultiplier tube having an S-20 response. Radiation for the thermal channel is re-imaged by means of a relay lens onto an intrinsic long wavelength detector. A 10.5 to 12.6 micron bandpass filter is located in the converging beam of the relay lens system and establishes the spectral band limits for the thermal channel.

PARAMETER SUMMARY:

Dimensions:	Scanner - 152.4 x 64.8 x 649.0 cm (60.0 x 25.5 x 255.5 in.) Electronics Module - 7,375.5 cu. cm (450 cu. in.)
Weight:	Scanner - 65.1 kg (143.3 lbs) Electronics Module - 6.6 kg (14.5 lbs)
Power:	22.3 W Average, 52 W Peak
Range:	0.55 to 0.70 microns 10.5 to 12.6 microns
Resolution:	0.9 km in daylight and 9.3 km at night
Filter:	10.5 to 12.6 micron bandpass
Telescope:	291.3 cm (114.7 in.) focal length, 40.6 cm (16.0 in.) aperture
IFOV:	8 visible channels, each 0.021 mr x 0.025 mr 2 thermal channels, each at 0.25 mr x 0.25 mr
Filters:	Irtran 2 window for the thermal detectors
Detectors:	HgCdTe
Precision & Accuracy:	Signal Dynamic Range of 44 db - visible; 27 db - infrared

SOURCE:

Data:	SMS Project Office, Goddard Space Flight Center
Reference:	Santa Barbara Research Center, Technical Proposal No. SM6-69 - Visible Infrared Spin-Scan Radiometer (VISSR) for a Synchronous Meteorological Spacecraft. Stephen, A.A., et. al., Data Flow in the Synchronous Meteorological Satellite System.



SMS-A Visible and Infrared Spin Scan Radiometer

EXPERIMENT CATEGORY: Ionizing Radiation

DATE OF LAUNCH: November, 1974

INSTRUMENT NAME: Energetic Electron Detector

SPACECRAFT: Helios A

DESTINATION: Solar Probe

PRINCIPAL INVESTIGATOR: E. Keppler, Max Planck Institut für Aeronomie, Lindau/Harz

INSTRUMENT CONTRACTOR:

PURPOSE: To measure medium energy electrons, protons, and positrons.

DESCRIPTION: This instrument consists of a magnetic spectrometer and electronics box. It shall measure the flux of: (1) electrons in the energy range 30 keV to 1 MeV in 16 energy channels, (2) protons in the energy range 40 keV to 2.5 MeV in 18 energy channels, (3) positrons in the energy range of about 50 keV to 215 keV in 6 energy channels. The sensor viewing axis is inclined by 8° towards North with respect to the orbit plane. The sensor unit will be mounted close to the outer skin of the spacecraft. The electronics unit will be mounted at a distance of no more than 50 cm from the sensor unit.

PARAMETER SUMMARY:

Dimensions: Sensor Unit - 20.0 cm (7.9 in.) long; rectangular area - 10.0 x 10.0 cm (3.9 x 3.9 in.), 11.5 cm (4.5 in.) diameter, 8.0 cm (3.1 in.) long
Electronics Unit - 8.2 x 10.0 x 30.0 cm (3.2 x 3.9 x 11.8 in.)

Weight: 3.5 kg (7.7 lbs)

Power: 2.8 W

Range: 30 keV - 1 MeV for electrons
40 keV - 2 MeV for protons
50 keV - 215 keV for positrons

SOURCE:

Data:

Gesellschaft für Weltraumforschung MBH, Project Plan for Helios-A and -B, March, 1971.

GSFC, Project Plan for Helios A and B, November, 1970.

Ousley, Gilbert and Ants Kutzer, Helios (Cooperative Solar Probe), presented to the Ninth International Symposium on Space Technology and Science, Tokyo, Japan, 17 May 1971.

Reference:

Gesellschaft für Weltraumforschung mbH, Helios Experiment Data Book, August, 1970.

EXPERIMENT CATEGORY:	Ionizing Radiation, High Energy Charged Particles
DATE OF LAUNCH:	November, 1974
INSTRUMENT NAME:	Cosmic Ray Particle Detector
SPACECRAFT:	Helios A
DESTINATION:	Solar Probe
PRINCIPAL INVESTIGATOR:	H.G. Hasler, Univ. of Kiel, Kiel, W. Germany
INSTRUMENT CONTRACTOR:	

PURPOSE: To gather information about particle flow, energy, and direction as a function of distance from the sun. To gather information about galactic cosmic rays, to measure solar particles close to the sun, to study propagation characteristics of solar protons, alpha particles, and electrons, to measure the spatial gradient and charge spectrum of galactic cosmic rays.

DESCRIPTION: The instrument consists of a sensor containing a detector telescope surrounded by an anticoincidence scintillation counter, a Cerenkov counter, and associated electronics. The 55° viewing cone is directed in the orbit plane. The instrument will measure the flux of: protons in the energy range 1 MeV to 1 GeV, as a function of angle and time; alpha particles in the energy range 4 MeV to 4 GeV, as a function of angle and time; nuclear particles with charge number $Z \leq 10$, as a function of energy and charge; nuclear particles with $Z > 10$, without any resolution; electrons in the energy range 0.2 MeV to 4 MeV as a function of angle and time.

PARAMETER SUMMARY:

Dimensions:	Sensor Unit - 28.0 (radial) x 21.0 x 12.0 cm (11.0 x 8.3 x 4.7 in.) Electronics Unit - 33.5 x 13.0 x 11.0 cm (13.2 x 5.1 x 4.3 in.)
Weight:	8.5 kg (18.7 lbs)
Power:	7.8 W
Range:	1-1,000 MeV/nucleon

SOURCE:

Data:

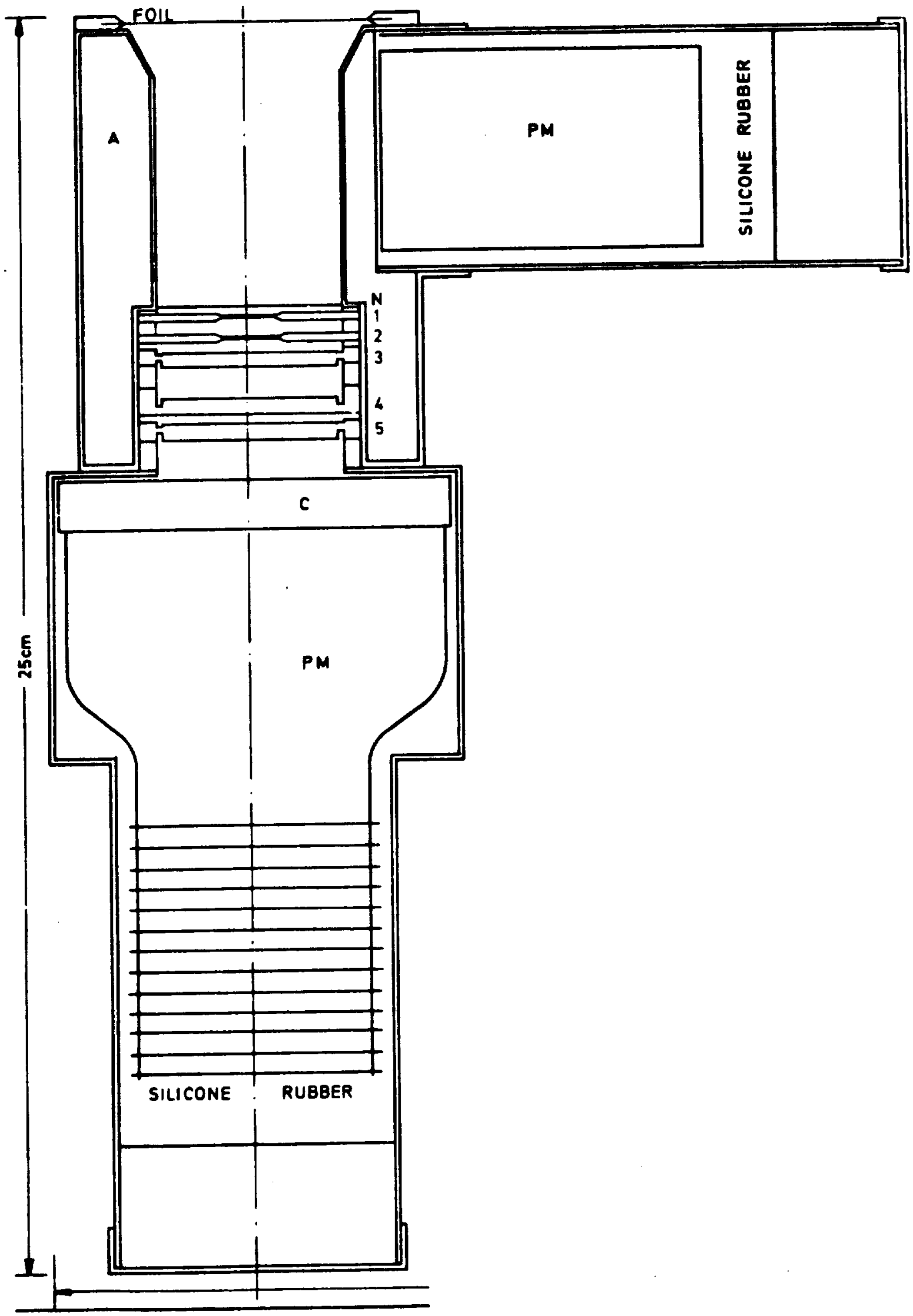
Gesellschaft für Weltraumforschung MBH, Project Plan for Helios-A and -B, March, 1971.

GSFC, Project Plan for Helios A and B, November, 1970.

Ousley, Gilbert and Ants Kutzer, Helios (Cooperative Solar Probe), presented to the Ninth International Symposium on Space Technology and Science, Tokyo, Japan, 17 May 1971.

Reference:

Gesellschaft für Weltraumforschung mbH, Helios Experiment Data Book, August, 1970.



Helios A Cosmic Ray Particle Detector

EXPERIMENT CATEGORY: Ionizing Radiation, High Energy Charged Particles

DATE OF LAUNCH: November, 1974

INSTRUMENT NAME: Cosmic Ray Telescopes

SPACECRAFT: Helios A

DESTINATION: Solar Probe

PRINCIPAL INVESTIGATOR: J.H. Trainor, NASA/GSFC

INSTRUMENT CONTRACTOR:

PURPOSE: To measure the entire energy range of 0.1 to about 800 MeV for protons and heavier particles and of 0.05 to 5 MeV for electrons. To study chemical and isotopic composition of galactic and solar cosmic rays. To monitor solar X-ray emission.

DESCRIPTION: This instrument consists of four particle telescopes (one for high energy, HET; one for low energy, LET; two for very low energy, VLET: an X-ray counter and associated electronics). It will measure: (1) charged particles with $1 \leq Z \leq 10$ in the entire range 0.1 MeV to about 800 MeV, (2) electrons in the range 0.05 MeV to 5 MeV and (3) solar X-ray emission in the spectral range 1.5 Å to 12 Å. All sensors view into the orbit plane. The viewing cones of the detectors are: HET - 35° double cone, viewing into opposite directions tangentially to spacecraft equator, LET - 50° viewing radially outwards, VLET - 30° viewing outwards, cone axes inclined by ± 20° to spacecraft equator, X-ray - approximately 4°, viewing radially outwards.

PARAMETER SUMMARY:

Dimensions: X-ray detector - 10.0 (width) x 15.0 (radial) x 10.0 cm (3.9 x 5.9 x 3.9 in.)
HET - 5.0 (width) x 10.0 x 5.0 cm (2.0 x 3.9 x 2.0 in.)
LET - 3.5 (width) x 4.5 (radial) x 3.5 cm (1.4 x 1.8 x 1.4 in.)
VLET - 3.2 (width) x 3.5 x 3.2 cm (1.3 x 1.4 x 1.3 in.)

Weight: 3.6 kg (7.9 lbs)

Power:	3.1 W
Range:	0.1 - 800 MeV for charged particles 0.05 - 5 MeV for electrons
Spectral Range:	1.5-12 Å for solar X-ray emission
SOURCE:	
Data:	Gesellschaft für Weltraumforschung MBH, Project Plan for Helios-A and -B, March, 1971. GSFC, Project Plan for Helios A and B, November, 1970. Ousley, Gilbert and Ants Kutzer, Helios (Cooperative Solar Probe), presented to the Ninth International Symposium on Space Technology and Science, Tokyo, Japan, 17 May 1971.
Reference:	Gesellschaft für Weltraumforschung mbH, Helios Experiment Data Book, August, 1970.

EXPERIMENT CATEGORY:	Magnetic Field
DATE OF LAUNCH:	November, 1974
INSTRUMENT NAME:	Fluxgate Magnetometer
SPACECRAFT:	Helios A
DESTINATION:	Solar Probe
PRINCIPAL INVESTIGATOR:	G. Musmann, TU Braunschweig, W. Germany
INSTRUMENT CONTRACTOR:	

PURPOSE: To measure the quasistatic component of the interplanetary magnetic field in the frequency range from 0 to 4.7 Hz; also, to measure magnetic shock waves.

DESCRIPTION: This instrument is a triaxial fluxgate magnetometer. It consists of one sensor unit and two electronics units. The boom serves as a mounting platform for the sensor unit. The two ranges are 0-102.4 gamma (± 0.4 gamma resolution) and 97.6-401.2 gamma (± 1.2 gamma resolution). The sensor unit will be mounted with its ground plate on a radial boom near the equatorial plane of the spacecraft. The analog electronics unit will be mounted close to the sensor boom support. The sensor boom will be nominally radial to the spacecraft spin axis.

PARAMETER SUMMARY:

Dimensions:	Sensor Unit - 15.0 x 15.0 x 25.0 cm (5.9 x 5.9 x 9.8 in.) Analog & Digital Electronics - 14.0 x 14.0 x 32.5 cm (5.5 x 5.5 x 12.8 in.)
Weight:	4.8 kg (10.6 lbs)
Power:	7.2 W continuous, 8.2 W peak
Frequency Range:	0-4.7 Hz
Measuring Rate:	8 vectors per rev.

SOURCE:

Data:

Gesellschaft für Weltraumforschung MBH, Project Plan for Helios-A and -B, March, 1971.

GSFC, Project Plan for Helios A and B, November, 1970.

Ousley, Gilbert and Ants Kutzer, Helios (Cooperative Solar Probe), presented to the Ninth International Symposium on Space Technology and Science, Tokyo, Japan, 17 May 1971.

Reference:

Gesellschaft für Weltraumforschung mbH, Helios Experiment Data Book, August, 1970.

EXPERIMENT CATEGORY:	Magnetic Field
DATE OF LAUNCH:	November, 1974
INSTRUMENT NAME:	Fluxgate Magnetometer
SPACECRAFT:	Helios A
DESTINATION:	Solar Probe
PRINCIPAL INVESTIGATOR:	N.F. Ness, NASA/GSFC
INSTRUMENT CONTRACTOR:	

PURPOSE: To measure interplanetary magnetic field directions and magnitude.

DESCRIPTION: This instrument consists of one sensor unit and one electronics unit, which is divided into two parts: fluxgate analog electronics unit and digital data handling unit. The instrument will be adapted to varying bit rates in order to allow for high time resolution when high telemetry bit rates will be available. The sensor unit should be mounted with its common circular ground plate at the end of a radial boom near the equatorial plane of the spacecraft.

PARAMETER SUMMARY:

Dimensions:	Sensor Unit - 15.0 x 15.0 x 25.0 cm (5.9 x 5.9 x 9.8 in.) Electronics Unit - 10.0 x 20.0 x 25.0 cm (3.9 x 7.9 x 9.8 in.)
Weight:	3.7 kg (5.1 lbs)
Power:	3.5 W continuous, 7.5 W peak
Ranges (Accuracies):	± 25 gamma (± 0.1 gamma) ± 75 gamma (± 0.3 gamma) ± 225 gamma (± 0.9 gamma)
Frequency Range:	0 to approximately 8 Hz

SOURCE:

Data:	Gesellschaft für Weltraumforschung MBH, Project Plan for Helios -A and -B, March, 1971. GSFC, Project Plan for Helios A and B, November, 1970. Ousley, Gilbert and Ants Kutzer, Helios (Cooperative Solar Probe), presented to the Ninth International Symposium on Space Technology and Science, Tokyo, Japan, 17 May 1971.
Reference:	Gesellschaft für Weltraumforschung, mbH, Helios Experiment Data Book, August, 1970.

EXPERIMENT CATEGORY: Magnetic Field

DATE OF LAUNCH: November, 1974

INSTRUMENT NAME: Search Coil Magnetometer

SPACECRAFT: Helios A

DESTINATION: Solar Probe

PRINCIPAL INVESTIGATOR: G. Dehmel, TU Braunschweig, W. Germany

INSTRUMENT CONTRACTOR:

PURPOSE: To measure magnetic field fluctuations and shock wave forms.

DESCRIPTION: This instrument is a search coil magnetometer on a radial boom with an elecrronics box inside the spacecraft. For axis parallel to spacecraft spin axis, spectral resolution will be obtained. Because of low data rate available, short term high-resolution data on events (shocks) is accomplished using onboard data storage. The frequency range contains the expected electron gyro frequency for the most probable field strengths (up to about 110 gamma). The resolution ranges from 1.5 milligamma rms in the band 4.7 Hz to 10 Hz to 0.2 milligamma rms in the band 2.2 kHz to 3.4 kHz. The instrument measures the time derivative of the magnetic field strength (dH/dt), the measuring range is 10^4 gamma Hz.

PARAMETER SUMMARY:

Dimensions: Sensor Unit - 35.0 x 35.0 x 35.0 cm (13.8 x 13.8 x 13.8 in.)
Electronics Unit - 12.0 x 12.0 x 20.0 cm (4.7 x 4.7 x 7.9 in.)

Weight: 3.0 kg (6.6 lbs)

Power: 5.5 W

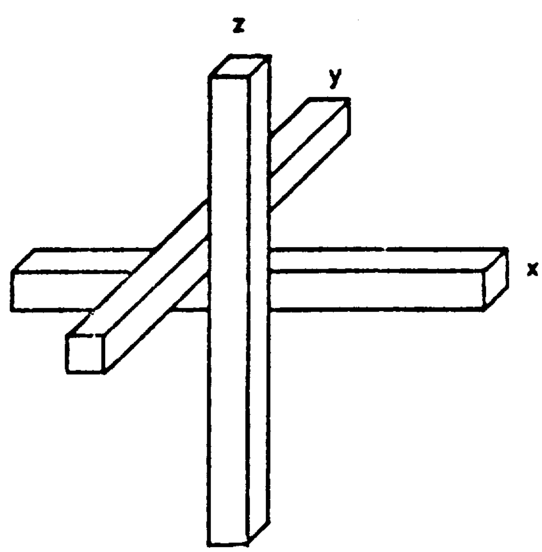
Frequency Range: 4.7 Hz to approximately 3.4 kHz

Measuring Range: 10^4 gamma Hz

SOURCE:

Data: Gesellschaft für Weltraumforschung MBH, Project Plan for Helios -A and -B, March, 1971.
GSFC, Project Plan for Helios A and B, November, 1970.
Ousley, Gilbert and Ants Kutzer, Helios (Cooperative Solar Probe), presented to the Ninth International Symposium on Space Technology and Science, Tokyo, Japan, 17 May 1971.

Reference: Gesellschaft für Weltraumforschung, mbH, Helios Experiment Data Book, August, 1970.



Helios A Search Coil Magnetometer, Triaxial Sensor Arrangement

EXPERIMENT CATEGORY:	Micrometeoroid
DATE OF LAUNCH:	November, 1974
INSTRUMENT NAME:	Micrometeoroid Analyzer
SPACECRAFT:	Helios A
DESTINATION:	Solar Probe
PRINCIPAL INVESTIGATOR:	H. Fechtig, Max Planck Institut für Kernphysik, Heidelberg, W. Germany
INSTRUMENT CONTRACTOR:	

PURPOSE: To measure dust particles.

DESCRIPTION: This instrument consists of two sensor tubes and two electronics units. Each sensor covers a total field of view of 60°. The field of view of the so-called ecliptic sensor will comprise the ecliptic plane and, therefore, the tube axis has to be inclined by no more than 30° North, with respect to the spacecraft equator. The field of view of the other sensor will not comprise the ecliptic plane and is asymmetric with respect to the tube axis which will be inclined by 30° South to the spacecraft equator. The instrument will measure the mass, range $m > 10^{-15}$ g, velocity, range 2 km/s to 100 km/s, chemical composition in the range of atomic weights from M = 15 to M = 70, angle of incident dust particles.

PARAMETER SUMMARY:

Dimensions: Sensor Units - 120 cm (47.3 in.) long, 16 cm (6.3 in.) diameter
Electronics Units - 10.0 x 10.4 cm (3.9 x 4.1 in.), 21.5 cm (8.5 in.) and 14.3 cm (5.5 in.) in length

Weight: 10.4 kg (22.9 lbs)

Power: 6.5 W

Range: $> 10^{-15}$ g mass
2 km/s to 100 km/s velocity
M = 15 to M = 70 (atomic weights) chemical composition

Field of View: 60°

SOURCE:

Data: Gesellschaft für Weltraumforschung MBH, Project Plan for Helios-A and -B, March, 1971.
GSFC, Project Plan for Helios A and B, November, 1970.
Ousley, Gilbert and Ants Kutzer, Helios (Cooperative Solar Probe), presented to the Ninth International Symposium on Space Technology and Science, Tokyo, Japan, 17 May 1971.

Reference: Gesellschaft für Weltraumforschung mbH, Helios Experiment Data Book, August, 1970.

EXPERIMENT CATEGORY:	Plasma
DATE OF LAUNCH:	November, 1974
INSTRUMENT NAME:	Plasma Detectors
SPACECRAFT:	Helios A
DESTINATION:	Solar Probe
PRINCIPAL INVESTIGATOR:	H.A. Rosenbauer, Max Planck Institut für Physik and Astrophysik, Garching/Munich
INSTRUMENT CONTRACTOR:	

PURPOSE: To study the directional intensity of the protons, alpha particles, and electrons in the solar wind.

DESCRIPTION: This instrument consists of: Sensor Box 1 containing (a) a quarter-sphere electrostatic analyzer to observe protons and heavier ions, energy range is 0.20 keV to 16 keV in 32 logarithmically spread channels and viewing field-elevation ± 40° with 5° resolution, (b) a half-sphere electrostatic analyzer in connection with an electrometer to observe protons and heavier ions, energy range is 0.20 keV to 16 keV in 32 logarithmically spread channels and viewing field-elevation ± 40° azimuth ± 40° with no angular resolution. Time resolution for (a) and (b) is nominal 30 s or longer. Sensor Box 2 containing a half-sphere electrostatic analyzer to measure electrons, energy range is 1 eV to 1 keV in 32 channels and viewing field-elevation ± 20°, azimuth 360° in 8 channels of 45° width, time resolution - 60 s. Sensor Box 3 containing an electrodynamic analyzer, covering solar wind velocities from 200 to 800 km/s and a mass per charge ratio 1 to 5 in 25 steps, viewing field-elevation ± 40° with 5° resolution. An electronics box also is part of this instrument.

PARAMETER SUMMARY:

Dimensions: Sensor Units - 65.0 cm (25.6 in.) radial, 55 cm (21.7 in.) width, 50 cm (19.7 in.) height
Electronics Unit - 20.0 x 20.0 x 40.0 cm (7.9 x 7.9 x 15.8 in.)

Weight:	9.5 kg (20.9 lbs)
Power:	13.0 W
Range:	0.20 keV - 16.0 keV 1 eV - 1 keV
Viewing Field:	Elevation ± 40° with 5° resolution Elevation ± 40°, azimuth ± 40° with no angular resolution Elevation ± 20°, azimuth 360°

SOURCE:

Data:	Gesellschaft für Weltraumforschung MBH, Project Plan for Helios-A and -B, March, 1971. GSFC, Project Plan for Helios A and B, November, 1970. Ousley, Gilbert and Ants Kutzer, Helios (Cooperative Solar Probe), presented to the Ninth International Symposium on Space Technology and Science, Tokyo, Japan, 17 May 1971.
Reference:	Gesellschaft für Weltraumforschung mbH, Helios Experiment Data Book, August, 1970.

EXPERIMENT CATEGORY: Plasma

DATE OF LAUNCH: November, 1974

INSTRUMENT NAME: Plasma and Radio Wave Detector

SPACECRAFT: Helios A

DESTINATION: Solar Probe

PRINCIPAL INVESTIGATOR: D.A. Gurnett, University of Iowa

INSTRUMENT CONTRACTOR:

PURPOSE: To observe electrostatic and electromagnetic wave phenomena, electrical shock waves.

DESCRIPTION: This experiment consists of an electric field antenna, minimum length 16 m tip to tip, which provides signals to: (1) a 16-channel spectrum analyzer with a frequency range of 6.8 Hz to 237 kHz, a frequency resolution of 30%, and a time resolution of less than 1 sec, (2) a narrow-band step-frequency receiver with a frequency range of 10 Hz to 200 kHz, a frequency resolution of about 4%, and a time resolution of about 1 min, (3) a dual swept frequency radiometer with a frequency range of 50 kHz to 3 MHz and 16 channels with a bandwidth of not greater than 30 kHz.

PARAMETER SUMMARY:

Dimensions: 85.5 x 84.2 x 71.8 cm (33.7 x 33.2 x 28.3 in.) (total)

Weight: 8.1 kg (17.8 lbs)

Power: 9.3 W

Frequency Ranges: 6.8 Hz - 237 kHz
10 Hz - 200 kHz
50 kHz - 3 MHz

Frequency Resolutions: 30%
4%

Viewing Cone: 55°

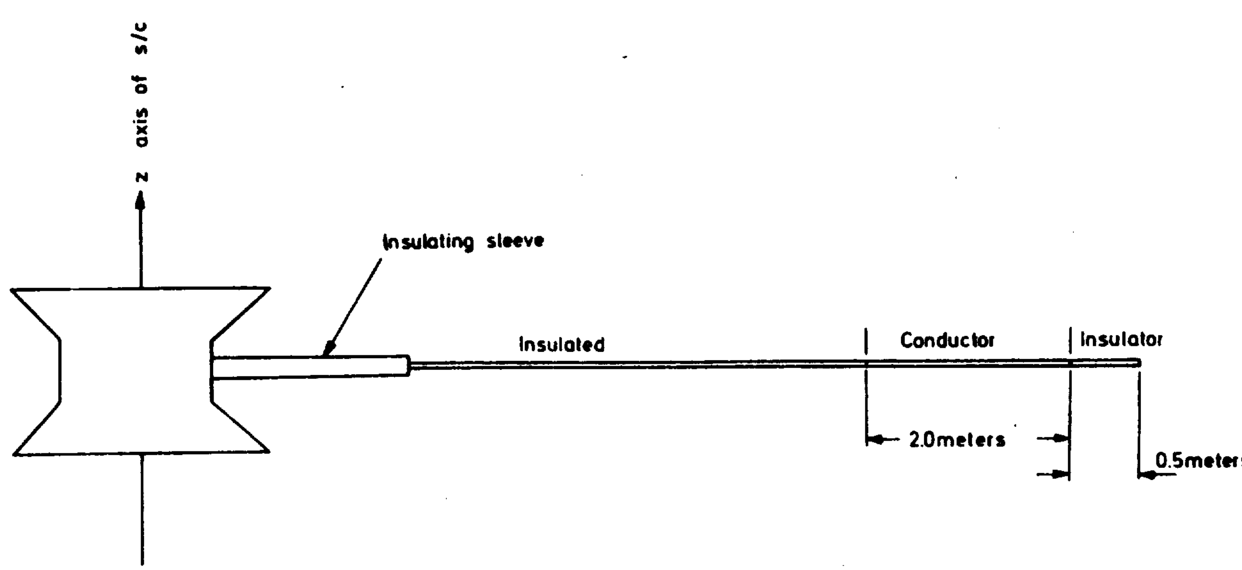
SOURCE:

Data: Gesellschaft für Weltraumforschung MBH, Project Plan for Helios-A and -B, March, 1971.

GSFC, Project Plan for Helios A and B, November, 1970.

Ousley, Gilbert and Ants Kutzer, Helios (Cooperative Solar Probe), presented to the Ninth International Symposium on Space Technology and Science, Tokyo, Japan, 17 May 1971.

Reference: Gesellschaft für Weltraumforschung mbH, Helios Experiment Data Book, August, 1970.



Helios A Plasma and Radio Wave Detector

EXPERIMENT CATEGORY: Ultraviolet and Visible Frequency Photometry

DATE OF LAUNCH: November, 1974

INSTRUMENT NAME: Zodiacal Light Photometer

SPACECRAFT: Helios A

DESTINATION: Solar Probe

PRINCIPAL INVESTIGATOR: C. Leinert, Landessternwarte, Heidelberg, W. Germany

INSTRUMENT CONTRACTOR:

PURPOSE: To obtain information about the spatial distribution, size, and nature of interplanetary dust particles. To observe wavelengths and measure polarization of zodiacal light.

DESCRIPTION: This instrument consists of three photometer tubes and an electronics box. The photometer axes are inclined by 15°, 30° and 90° towards the South with respect to the orbit plane. Each photometer will observe the zodiacal light in the white light and in the wavelength bands at 5500 Å and at 4000 Å. Additionally, the polarization of the zodiacal light will be measured. Each photometer measures the zodiacal light as a function of wavelength, polarization, and azimuth of the photometer. The viewing cones of the photometers are 1°, 2°, and 3°. The three photometers look to the south.

PARAMETER SUMMARY:

Dimensions:
Electronics Unit - 15.0 x 20.0 x 10.0 cm (5.9 x 7.9 x 3.9 in.)
15° Photometer - 40.0 to 50.0 cm long (15.7 to 19.7 in.), 6.0 to 10.0 cm diameter (2.4 to 3.9 in.)
Baffle Tube - 125.0 cm long (49.2 in.), 10.0 cm diameter (3.9 in.)
30° Photometer - 45.0 cm long (17.7 in.), 10.0 cm diameter (3.9 in.)
Baffle Tube - 80.0 cm long (31.5 in.), 10.0 cm diameter (3.9 in.)
90° Photometer - 45.0 cm long (17.7 in.), 10.0 cm diameter (3.9 in.)
Baffle Tube - 60.0 cm long (23.6 in.), 16.0 cm diameter (6.3 in.)

Weight:	9.2 kg (20.2 lbs)
Power:	6.9 W continuous, 9.6 W peak
Viewing Cones:	1°, 2°, 3°

SOURCE:

Data:	Gesellschaft für Weltraumforschung MBH, Project Plan for Helios-A and -B, March, 1971. GSFC, Project Plan for Helios A and B, November, 1970. Ousley, Gilbert and Ants Kutzer, Helios (Cooperative Solar Probe), presented to the Ninth International Symposium on Space Technology and Science, Tokyo, Japan, 17 May 1971.
Reference:	Gesellschaft für Weltraumforschung mbH, Helios Experiment Data Book, August, 1970.

EXPERIMENT CATEGORY: Ultraviolet Photometry

DATE OF LAUNCH: November, 1974

INSTRUMENT NAME: Extreme Ultraviolet Radiation from Earth/Space Instrument

SPACECRAFT: OSO-I

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: C.S. Weller, U.S. Naval Research Laboratory

INSTRUMENT CONTRACTOR:

PURPOSE: To obtain spatial and temporal measurements of extreme ultraviolet emissions of hydrogen, helium, and oxygen in the earth's atmosphere and in interplanetary and galactic space.

DESCRIPTION: The instrument consists of two photometers designed to measure XUV resonance radiation in various wavelengths from 170 - 1080 Å and in portions of 1130-1500 Å wavelength range. Each photometer consists of a continuous channel electron multiplier used as a photon detector together with a thin metal film or a magnesium fluoride-oxygen cell to serve as an optical bandpass filter. There are four such bandpass filters: a thin film of aluminum (approximately equal to 1000 Å thick) and carbon (approximately equal to 500 Å thick); a thin film of aluminum (approximately equal to 1000 Å thick); a thin film of indium (approximately equal to 1500 Å thick); and a cell with magnesium fluoride windows filled with one atmosphere of oxygen. The bandpass filters are mounted on a wheel in front of the photomultipliers which is rotated at regular intervals to change the filters. This will make two of the listed wavelength range sensitive at any given time. The channel type photomultipliers combine gain (approximately equal to 10^8) and low noise (1 count/sec at 10^8 gain) with small size and light weight. They have quantum efficiencies from 0.02 - 0.25 over the range 300 - 1200 Å, and are "blind" to radiation wavelengths greater than 1500 Å. They have been used successfully as ion and photon detectors in experiments on rockets, and recently as photon detectors on a solar spectroscopy experiment on the OSO-V satellite. These thin metallic films are excellent devices to obtain a broad XUV bandpass filter with relatively low transmission loss. They have been used successfully in solar spectroscopy and atmospheric resonance radiation experiments on rockets. The magnesium fluoride-oxygen cell has a very narrow bandpass with four sharp peaks, one of which is practically centered on Lyman A. This provides a marked improvement in both sensitivity and spectral resolution over LiF - NO ion chambers previously used. The instrument will be mounted in the wheel section with the photometer axes at a small angle with respect to the satellite-sun line and with sufficient baffling such that the photometers would never "see" the sun.

PARAMETER SUMMARY:

Dimensions:	16,390 cm^3 (1000 $in.^3$)
Weight:	6.8 kg (15.0 lbs)
Power:	2 W
Wavelength Range:	(Bandpass Filters) 170 - 440 Å for Al-C filter - photomultiplier 170 - 800 Å for Al filter - photomultiplier 730 - 1080 Å for In filter - photomultiplier Portions of 1130 - 1500 Å for MgF_2-O_2 filter photomultiplier
Resolution:	Transmission bandpass filters
Field of View:	40°
Detectors:	3 channel electron multipliers
Telemetry:	300 bps
Commands:	14 pulse

SOURCE:

Data:	John L. Donley, OSO Experiment Manager, Goddard Space Flight Center.
Reference:	Same as above.

EXPERIMENT CATEGORY:	Ultraviolet Spectroscopy
DATE OF LAUNCH:	November, 1974
INSTRUMENT NAME:	High Resolution Ultraviolet Spectrometer
SPACECRAFT:	OSO-I
DESTINATION:	Earth Orbit
PRINCIPAL INVESTIGATOR:	Elmo C. Bruner, Jr., University of Colorado
INSTRUMENT CONTRACTOR:	SCI, Huntsville, Alabama EMR, Princeton, New Jersey Moore Tool Company, Bridgeport, Connecticut

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PURPOSE: To measure solar ultraviolet line shapes, within the 1130 to 2350 Å range, and their variation with time and with position on the disk; to make spectroheliograms in selected parts of the profiles of some lines; and to obtain information on terrestrial atmospheric effects of solar ultraviolet radiation.

DESCRIPTION: Selected solar ultraviolet line shapes are measured with a high resolution Ebert spectrometer mounted in the OSO sail. This instrument can operate in several different modes. The instrument has enough self-contained logic that the different modes can be implemented by ground command. Sunlight enters a Cassegrain telescope, strikes a primary mirror, and is then reflected to a secondary mirror which images the solar disk on the entrance slit of an Ebert monochromator. Light from the entrance slit fills half of the Ebert mirror. The mirror collimates the light and reflects it to fill a grating. Diffracted light from the grating strikes the remaining half of the Ebert mirror which focuses it on an exit slit. Light passing through the exit enters a sensor and is converted to signals that are proportional to intensity. Pulses from the photomultiplier tube are amplified and counted for an increment of time. These counts are stored in a data buffer until they can be read into the spacecraft data storage system. The sequence control contains the necessary logic to operate the instruments and also stores the locations of the lines to be observed in any given experiment.

PARAMETER SUMMARY:

Dimensions:	17.8 x 38.1 x 137.2 cm (7.0 x 15.0 x 54.0 in.)
Weight:	57.2 kg (126.0 lbs)
Power:	17 W
Spectral Range & Resolution:	λ (Å): 1130-2350; Δ λ (Å): .01
Telescope:	Type - Cassegrain Focal Length - 1.8 m Aperture - f 15 Primary Mirror - 13 x 13 cm Resolution - 1 x 5 sec/arc to 1 x 900 sec/arc, selectable
Spectrometer:	Channels - 1 Type - Ebert Element - Plane grating, 3600 line/mm
Detectors:	2 EMR photomultipliers
Telemetry:	550 bps
Commands:	15 pulse, 4 serial (16 bit)

SOURCE:

Data:	John L. Donley, OSO Experiment Manager, Goddard Space Flight Center.
Reference:	Same as above.

EXPERIMENT CATEGORY: Ultraviolet Spectrometry

DATE OF LAUNCH: November, 1974

INSTRUMENT NAME: Multichannel High Resolution Ultraviolet Spectrometer

SPACECRAFT: OSO-I

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: R.M. Bonnet, Centre National de la Recherche Scientifique, Verrieres le Buisson, France

INSTRUMENT CONTRACTOR:

PURPOSE: To observe the solar chromospheric structure simultaneously in several lines from 1000 to 4000 Å that originate from different levels in the atmosphere of the sun. The lines are: H and K of Calcium II; H and K of Magnesium II; Lyman Alpha and Lyman Beta of Hydrogen.

DESCRIPTION: The instrumentation is composed of a spectrometer and a Cassegrain telescope with a fine pointing system. This system can work in two modes: (1) a steady solar mode in which the pointing system is fixed on a solar location and by rotation of a grating, the spectrometer gives the simultaneous profiles of H and K Ca II, H and K Mg II, Lyman Alpha and Lyman Beta lines (2) a fine scanning solar mode in which the grating is fixed on three wavelengths of K Ca II, K Mg II and Lyman Alpha lines, and the fine pointing system scans a region of 1 ft by 1 ft on the sun. The ability to offset the direction of observation allows the study of several parts of the sun from the center to the limb of the disk. The secondary mirror is mounted on an actuator platform allowing the direction of the reflected beams to be tilted in two directions. The actuator consists of two electromagnets. A plane mirror with a pinhole in its center is located in front of the Cassegrain focus; it folds the beam in the direction of the instrument fine pointing control system. The light passing through the pinhole is focused on the slit of a spectrometer. The light enters the spectrometer through a small square hole (15 by 15 microns) which is located just behind the path folding plane mirror. The entrance hole is made by two right angle crossed slits delineating an area of 1 by 1 arc second on the solar disk.

PARAMETER SUMMARY:

Dimensions:	20.3 x 38.1 x 142.2 cm (8.0 x 15.0 x 56.0 in.)
Weight:	58.6 kg (129.0 lbs)
Power:	17.5 W

Spectral Range & Resolution:

λ (Å)	Δλ (Å)
1017-1032	.02
1206-1224	.02
2771-2824	.02
3914-3982	.06

Telescope:
Type - Cassegrain
Focal Length - 3 meters
Aperture - f 16
Collecting Area - 183 cm^3
Primary Mirror - 16 cm diameter
Resolution - 1 x 1 sec to 1 x 40 sec, selectable

Spectrometer:
Channels - 6
Type - Czerny-Turner
Element - Plane Grating, 1200 grooves/mm

Detectors:	4 photomultipliers, 1 spiraltron
Telemetry:	600 bps
Commands:	29 pulses, 4 serial (16 bit)

SOURCE:

Data:	John L. Donley, OSO Experiment Manager, Goddard Space Flight Center
Reference:	Same as above.

EXPERIMENT CATEGORY: X-Ray

DATE OF LAUNCH: November, 1974

INSTRUMENT NAME: Cosmic X-Ray Spectroscopy

SPACECRAFT: OSO-I

DESTINATION: Earth Orbit

PRINCIPAL INVESTIGATOR: E.A. Boldt, Goddard Space Flight Center

INSTRUMENT CONTRACTOR: Time-Zero Corporation, Torrance, California

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PURPOSE: To obtain the spectra of X-ray sources and the diffuse background in the energy range of 2 to 60 keV.

DESCRIPTION: The instrument is mounted in the wheel so that it is offset from the spin axis by about five degrees. The X-ray is accomplished with two proportional chambers filled, to somewhat over an atmosphere of pressure, with gas mixtures consisting predominantly of argon in one case and xenon in the other. The argon chamber emphasizes spectroscopy below about 10 keV while with xenon chamber emphasizes spectroscopy above about 10 keV, with significant overlap from about 5 to 15 keV. The gross window area of each counter is about 400 cm^2. The field of view of these detectors are fixed by mechanical collimators to be 1 by 5° for the argon filled chamber and 1 by 20° for the xenon filled chamber. These detectors are aligned so that their collimators are parallel, with the same angular field in the direction of tight collimation, i.e., 1° FWHM.

PARAMETER SUMMARY:

Dimensions: 98,340 cm^3 (6000 in^3)

Weight: 45.4 kg (100.0 lbs)

Power: 8.5 W

Measurement Range: 2 to 60 keV

Resolution: 64 channel PHA

Detectors:	Three collimated proportional counters 2 xenon-methane gas; window - 2 mil beryllium; area - 270 cm^2, 5° FWHM collimator 1 argon-methane gas; window - 2 mil beryllium; area - 70 cm^2; 3° FWHM collimator
Telemetry:	550 bps
Commands:	24 pulse, 3 serial (16 bit)
SOURCE:	
Data:	John L. Donley, OSO Experiment Manager, Goddard Space Flight Center.
Reference:	Same as above.

EXPERIMENT CATEGORY:	X-Ray
DATE OF LAUNCH:	November, 1974
INSTRUMENT NAME:	High Energy Celestial X-Rays
SPACECRAFT:	OSO-I
DESTINATION:	Earth Orbit
PRINCIPAL INVESTIGATOR:	K.J. Frost, Goddard Space Flight Center
INSTRUMENT CONTRACTOR:	Harshaw Chemical, Cleveland, Ohio Spacetac, Bedford, Massachusetts Exotech, Gaithersburg, Maryland American Beryllium, Sarasota, Florida

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PURPOSE: To measure the energy spectra of all known X-ray sources above the intensity threshold of 10^{-6} photons/cm^2 sec keV; and to measure time variations of both long term (with time scale of days) and short term periodic variations of the sources. The spectrum from each source is determined over as broad an energy range as possible to differentiate between the possible processes which produce the X-rays. Also, a search will be made for new X-ray sources with particular emphasis on regions of the sky within 10° of the galactic plane.

DESCRIPTION: The instrument consists essentially of a central scintillation crystal of CsI (Na). The sensitive area of the central crystal is 56.9 cm^2 and the average thickness of the shield is 5.08 cm (2.0 in.). The collimator is to be of the honeycomb type with holes drilled through the shield to the front surface of the central crystal giving a maximum geometrical acceptance angle of 6.3° from the axis of the holes. The detector is pointed with its axis almost parallel to the spin axis of the satellite. In this way, an X-ray source slowly drifts across the field of view of the detector as the spin axis moves up to 1° per day. By ensuring that the spin axis continues to point in the direction of the galactic plane, nearly all of the known X-ray sources will come within the field of view of the detector during the one year lifetime of the satellite. By pointing the detector a few degrees away from the spin axis, the background with the source not in the field of view can be monitored each wheel rotation. Thus, very long integration times can be achieved for a single source even if the background counting rate should change for any reason.

PARAMETER SUMMARY:

Dimensions:	98,340 cm^3 (6000 in^3)
Weight:	67.6 kg (149.0 lbs)
Power:	5.5 W
Measurement Range:	10 keV - 1 meV
Sensitive Area:	(Central Crystal) 56.9 cm^2
Average Shield Thickness:	5.08 cm (2.00 in.)
Maximum Geometrical Acceptance Angle:	6.3° from axis of holes
Resolution:	255 channel PHA
Field of View:	5.1° FWHM collimator
Detectors:	CsI (Na) crystal viewed by four photomultipliers with a CsI (Na) anticoincidence shield viewed by 12 photomultipliers. Central detector sensitive area - 26 cm^2.
Telemetry:	850 bps
Commands:	12 pulse, 2 serial (16 bit)

SOURCE:

Data:	John J. Donley, OSO Experiment Manager, Goddard Space Flight Center.
Reference:	Same as above.

EXPERIMENT CATEGORY:	X-Ray
DATE OF LAUNCH	November, 1974
INSTRUMENT NAME:	High Sensitivity Graphite Crystal Spectrometer & Polarimeter
SPACECRAFT:	OSO-I
DESTINATION:	Earth Orbit
PRINCIPAL INVESTIGATOR:	R. Novick, Columbia University
INSTRUMENT CONTRACTOR:	Time-Zero Corporation, Torrance, California EDC, Seattle, Washington LND, Oceanside, New York

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PURPOSE: To provide a continuous monitor of the sun's emission in the 2 to 8 keV range; to obtain a complete spectrum of the sun every 12 seconds during flares; and to obtain high resolution spectra of many celestial X-ray sources. To measure the polarization of stellar X-ray emission in the energy range 5-25 keV.

DESCRIPTION: The spectrometer is a slitless Bragg spectrometer designed to fit into the wheel. It makes use of the wheel rotation to scan through different Bragg angles. There are no moving parts in the instrument. The rays reflected at different angles are detected by different counters. A very large area (1000 cm^2) crystal of graphite is used for Bragg reflection. The reflected rays pass through a collimator which prevents the detectors from obtaining a direct view of the sky. Three proportional counter detectors are used, and the collimator in front of each one is set to optimize detection of the three photon energies 2 keV, 2.6 keV, and 5.2 keV corresponding to Bragg angles of 70, 45 and 15°. The field of view of the collimators is wide enough so that there is a continuous coverage over the range 2-8 keV (1.5-6.6 Å). The arrangement chosen gives the maximum sensitivity to the expected emission lines of silicon, sulfur, and iron. The instrument scans for different energies as the satellite rotates. A second slit-collimator limits the field of view to between 75 and 105° of the rotation axis. This reduces the confusion of different sources. The resolving power of the system is about 330 at 2 keV to

30 at 8 keV. The polarimeter utilizes Thompson-scattering to measure polarization by preferential scattering in blocks of low-Z material that are surrounded by proportional counters which detect the scattered X-rays. The polarimeter detector assembly is a single mechanical structure which encloses a gas volume common to all detectors. A collimator will limit the field of view along the spin axis to 8° full width at half maximum. The sensitivity of the polarimeter is such that for 1 day of observation a minimum polarization of the Crab Nebula of 2.8% with 99% confidence can be determined.

PARAMETER SUMMARY:

Dimensions:	98,340 cm^3 (6000 in^3)
Weight:	44.5 kg (98.0 lbs)
Power:	8 W
Measurement Range:	Spectrometer - 2 to 8 keV Polarimeter - 2.6 and 5.2 keV
Resolution:	32 channels PHA
Field of View:	Spectrometer - 3° x 85° Polarimeter - Approximately 1°
Detectors:	Spectrometer - 4 proportional counters; Argon-Xenon-CO_2 gas; window - 1 mil beryllium; effective area - 100 cm^2 Polarimeter - 2 proportional counters; Argon-Xenon-CO_2 gas; window - 2 mil beryllium; effective area - 150 cm^2
Telemetry:	500 bps
Commands:	35 pulse, 2 serial (16 bit)

SOURCE:

Data:	John L. Donley, OSO Experiment Manager, Goddard Space Flight Center.
Reference:	Same as above.

EXPERIMENT CATEGORY:	X-Ray
DATE OF LAUNCH:	November, 1974
INSTRUMENT NAME:	Mapping X-Ray Heliometer
SPACECRAFT:	OSO-I
DESTINATION:	Earth Orbit
PRINCIPAL INVESTIGATOR:	L.W. Acton, Lockheed Palo Alto Research Laboratory, Palo Alto, California
INSTRUMENT CONTRACTOR:	Time-Zero Corporation, Torrance, California

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PURPOSE: To obtain measurements of the location, spectrum, and intensity of intermediate energy X-rays (in the 2 to 30 keV energy range) from individual solar active regions (flaring as well as quiescent active regions will be studied); to acquire significant data about extra-solar X-ray sources, and to provide daily a map of the sun showing the location, the intensity, and an index of the spectral hardness of each source region.

DESCRIPTION: The instrument consists of three independent X-ray detection systems and a data accumulator and processor. Each detection system is composed of two gas-filled proportional counters which view space through a multiple-fan-beam collimator that limits their field of view in the narrow dimension to 2 arc minutes full width at half maximum. The primary detector of each system has an effective area of approximately 100 cm^2, and is complemented by a second detector of approximately 0.5 cm^2 area that is included behind each collimator for use during high flux conditions. Data from the three fan-beam scans will be combined to construct a map that gives the location and angular extent (to the limit permitted by count statistics and the 2 arc minute field of view) of observed X-ray sources.

PARAMETER SUMMARY:

Dimensions:	98,340 cm^3 (6000 in^3)
Weight:	39.0 kg (86.0 lbs)

Power:	9.5 W
Measurement Range:	2-30 keV Resolution - 16 channel PHA Field of View - 2 arc min FWHM Oda Collimator
Detectors:	3 - 60 cm^2 gas proportional counter, 8 mil Be window, 90% Argon - 10% Methane 2 - 2.3 cm^2 gas proportional counter, 8 mil Be window, 90% Xenon - 10% Methane 1 - 1 cm^2 gas proportional counter, 3 mil Be window, 90% Argon - 10% Methane
Telemetry:	580 bps
Commands:	40 pulse, 3 serial (16 bit)
SOURCE:	
Data:	John L. Donely, OSO Experiment Manager, Goddard Space Flight Center.
Reference:	Same as above.

EXPERIMENT CATEGORY:	X-Ray
DATE OF LAUNCH:	November, 1974
INSTRUMENT NAME:	Soft X-Ray Radiation
SPACECRAFT:	OSO-I
DESTINATION:	Earth Orbit
PRINCIPAL INVESTIGATOR:	W.L. Kraushaar, University of Wisconsin
INSTRUMENT CONTRACTOR:	Time Zero Corporation, Torrance, California EDC, Seattle, Washington LND, Oceanside, New York

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PURPOSE:

To study the galactic latitude dependence of the X-ray background radiation using proportional counters with narrow collimation as practical in the region of 0.13 to 35 keV. This has important bearings on the nature of radiation, including possible cosmological implications. Energy resolution will rely largely on selective window transmission rather than pulse height measurement. Rather than aiming towards scattered and short exposures for all parts of the sky, viewing is parallel and antiparallel to the wheel spin direction so that two single paths across the sky, galactic pole to galactic plane, are carefully surveyed with high statistical accuracy in about six months.

DESCRIPTION:

The instrument uses proportional counters to investigate the X-ray background in the energy region 0.13 to 35 keV with special emphasis on the very soft X-ray region. Two sets of three proportional counters view through 4° by 4° (FWHM) collimators parallel and antiparallel to the wheel spin direction. The solar sail (or specially designed shutters) will be used to help evaluate and understand the instrumental and local background. Sensitivity is such as to give about 1% statistical accuracy near the galactic poles and such that the sun could be detected (at 0.13 keV) if at 2 parsecs. Especially important features of the proposed instrument are the slow and detailed study on one part of the sky that can later be studied for features in the 21 cm radiation and the fact that a very large dynamic range in energy is covered by one set of instruments that can be calibrated relative to each other.

PARAMETER SUMMARY:

Dimensions:	98,340 cm^3 (6000 in^3)
Weight:	48.1 kg (106.0 lbs)
Power:	7.5 W
Measurement Range:	0.13 to 35 keV
Detectors:	Four sealed, two gas flow proportional counters, about 20 in^2 area each 2 - 0.13 to 3.5 keV, methane gas, 2 micron kimfol window, 6 channel PHA 2 - 0.8 to 7.0 keV, neon-CO_2 gas, 7.6 micron aluminum window, 3 channel PHA 2 - 1.5 to 35 keV, Xenon-nitrogen gas, 25 micron beryllium window, 7 channel PHA
Field of View:	4° FWHM hexagonal honeycomb collimator
Telemetry:	150 bps
Commands:	38 pulse, 1 serial (16 bit)

SOURCE:

Data:	John L. Donley, OSO Experiment Manager, Goddard Space Flight Center.
Reference:	Same as above.

EXPERIMENT CATEGORY:	Atmospheric Structure
DATE OF LAUNCH:	August, 1975
INSTRUMENT NAME:	Acceleration Sensors
SPACECRAFT:	Viking A (Lander)
DESTINATION:	Planet Mars
PRINCIPAL INVESTIGATOR:	Alvin Seiff, Ames Research Center
INSTRUMENT CONTRACTOR:	Martin Marietta Aerospace Hamilton Standard Systems Bell Aerospace Corporation

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PURPOSE: To measure the profiles of density, pressure, and temperature in the atmosphere of Mars at altitudes from 20 to 100 km, in situ.

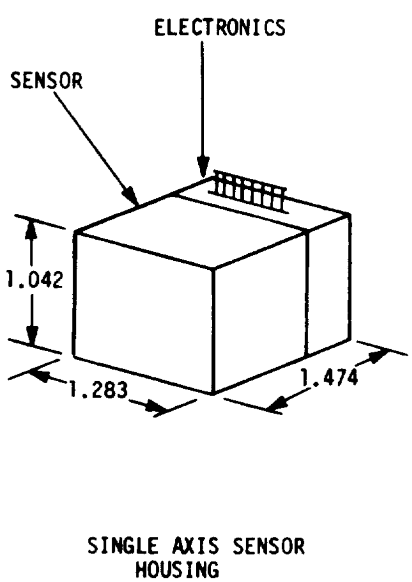
DESCRIPTION: A three axis acceleration sensor with a redundant sensor in the spacecraft axial direction will be used during entry and descent of the Viking spacecraft to define the density profile in the middle and lower atmosphere of Mars. The sensor, in combination with gyroscopes, will also permit the spacecraft velocity to be tracked, and the landing point estimated; in conjunction with radar altimeters and the terminal descent Doppler radar, it will define terrain under the flight path and atmospheric winds. The sensors are pendulous masses, suspended by flexures, and constrained to a null position by capacitive pick-offs and magnetic restoring torques. Basic sensor sensitivity is in the micro g range, but data accuracy will be telemetry limited to 0.1% full scale. Data from these sensors will be combined with those from pressure and temperature sensors to define altitude profiles of the atmospheric state parameters and the mean molecular weight from entry (approximately 100 km altitude) to touchdown.

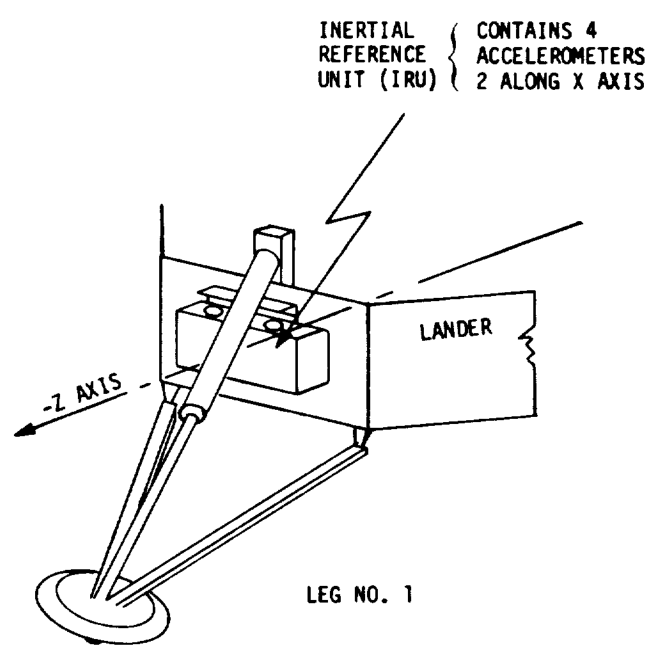
PARAMETER SUMMARY:

Dimensions: 4 units, each 3.7 x 3.3 x 2.6 cm (1.5 x 1.3 x 1.1 in.)

Weight: 135 g (4.8 oz.) for each unit

Power:	
Ranges:	Low 0 to 6 m/sec^2 High 0 to 150 m/sec^2
SOURCE:	
Data:	Alvin Seiff, Ames Research Center. Viking Project Office, Langley Research Center, PD 9600016.
Reference:	Alvin Seiff, Ames Research Center. "Entry Science Experiments for Viking 1975", Icarus, Vol. 16, No. 1 (February, 1972), p. 85-90.





Viking A Acceleration Sensors

EXPERIMENT CATEGORY: Atmospheric Structure

DATE OF LAUNCH: August, 1975

INSTRUMENT NAME: Entry Pressure Sensors

SPACECRAFT: Viking A (Lander)

DESTINATION: Planet Mars

PRINCIPAL INVESTIGATOR: Alvin Seiff, Ames Research Center

INSTRUMENT CONTRACTOR: Martin Marietta Aerospace

PURPOSE: To measure the pressure profile of Mars' atmosphere during entry. The sensor will also measure the meteorological variations with time on the surface.

DESCRIPTION: Two pressure sensors will be carried by the Viking lander during entry and descent through the Martian atmosphere. One is ported to the aeroshell stagnation region and is open and reading throughout high speed entry. The other is on one edge of the lander body, and is exposed at aeroshell deployment for sensing during the parachute phase. The latter instrument uses Kiel probe geometry to measure stagnation pressure over a range of lander attitudes. Both sensors are diaphragm type, with a sealed back chamber at zero reference pressure. Small diaphragm deflections are measured by a capacitive back plate. Data from these sensors, temperature sensors, and accelerometers will be combined to define altitude profiles of the atmospheric state parameters and mean molecular weight from touchdown to approximately 100 km altitude.

PARAMETER SUMMARY:

Dimensions: 5.8 x 7.6 x 5.8 cm (2.3 x 3.0 x 2.3 in.)

Weight: 421.7 g (14.9 oz.)

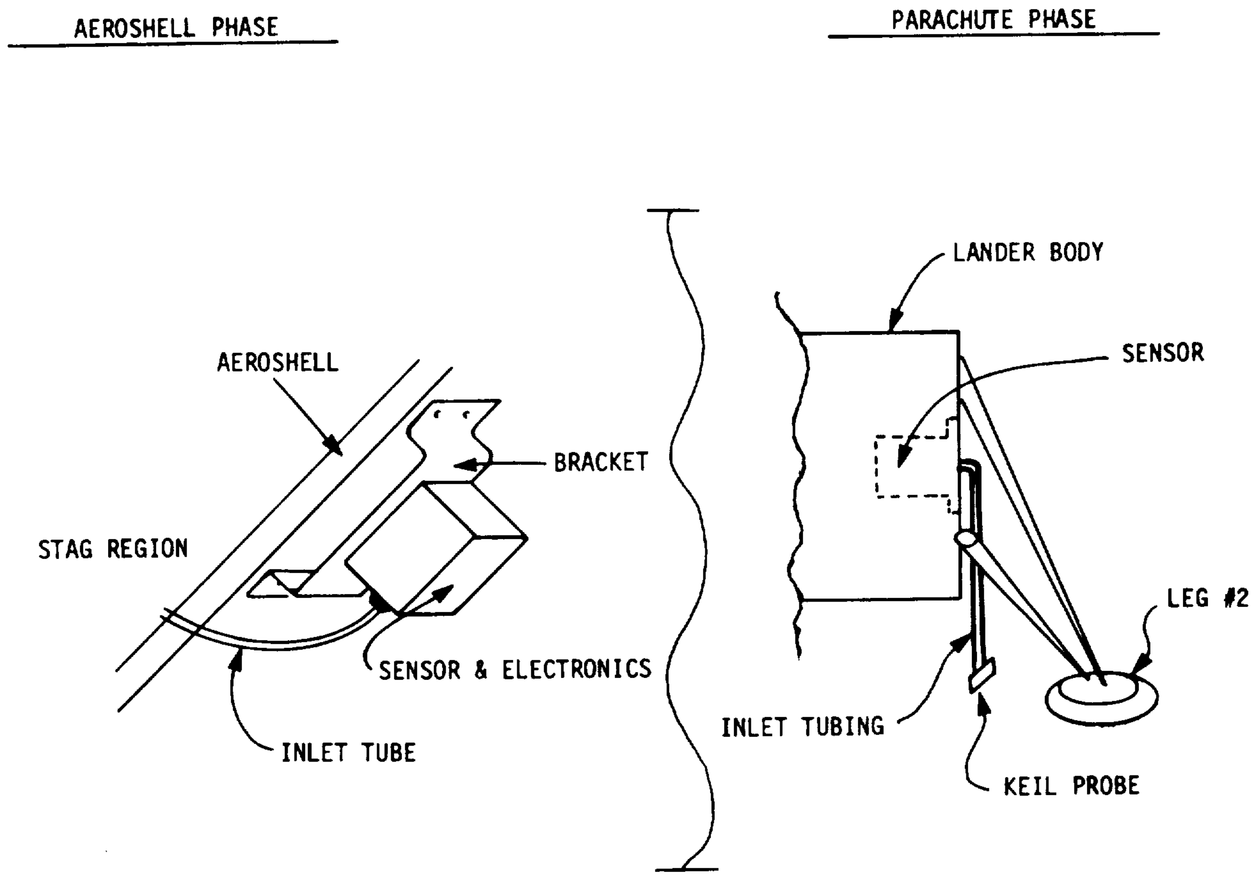
Power:

Range: Aeroshell - 0 to 150 mb
Parachute - 0 to 25 mb

SOURCE:

Data: Alvin Seiff, Ames Research Center
Viking Project Office, Langley Research Center, PD 7400069.

Reference: Alvin Seiff, Ames Research Center.
"Entry Science Experiments for Viking 1975," Icarus, Vol. 16, No. 1 (February, 1972), p. 85-90.



THIS INSTRUMENT USES A FLEXIBLE DIAPHRAM WHICH MOVES WITH RESPECT TO A FIXED CAPACITIVE BACKPLATE AND A VACUUM REF CHAMBER.

Viking A Entry Pressure Sensors

EXPERIMENT CATEGORY:	Atmospheric Structure
DATE OF LAUNCH:	August, 1975
INSTRUMENT NAME:	Entry Temperature Sensor
SPACECRAFT:	Viking A (Lander)
DESTINATION:	Planet Mars
PRINCIPAL INVESTIGATOR:	Alvin Seiff, Ames Research Center
INSTRUMENT CONTRACTOR:	Martin Marietta Aerospace

PURPOSE: To measure the temperature variation of Mars' atmosphere with altitude and with time on the surface.

DESCRIPTION: Two temperature sensors will be used to sense atmospheric temperatures during latter stages of entry and the entire parachute phase descent of the Viking Mars landers. The sensors are multiple thermocouples, three rows in series of three in each row in parallel. Sensors are staggered in height to avoid interference between rows. The aeroshell phase sensor is deployed outside the vehicle boundary layer through the heat shield near the base of the aeroshell on the bottom meridian, where response rates are maximum. Sensor diameter (1/8 mm) was chosen to respond to rapid variations in flow recovery temperature immediately after sensor deployment at a velocity of 1 km/sec. The parachute phase sensor is mounted on the inboard edge of footpad No. 2, where it is exposed to a vigorous through flow. Cold junction reference is a platinum resistance thermometer. Data from these sensors, the pressure sensors, and accelerometers will be combined to define altitude profiles of the atmospheric state parameters and the mean molecular weight from touchdown to approximately 100 km altitude.

PARAMETER SUMMARY:

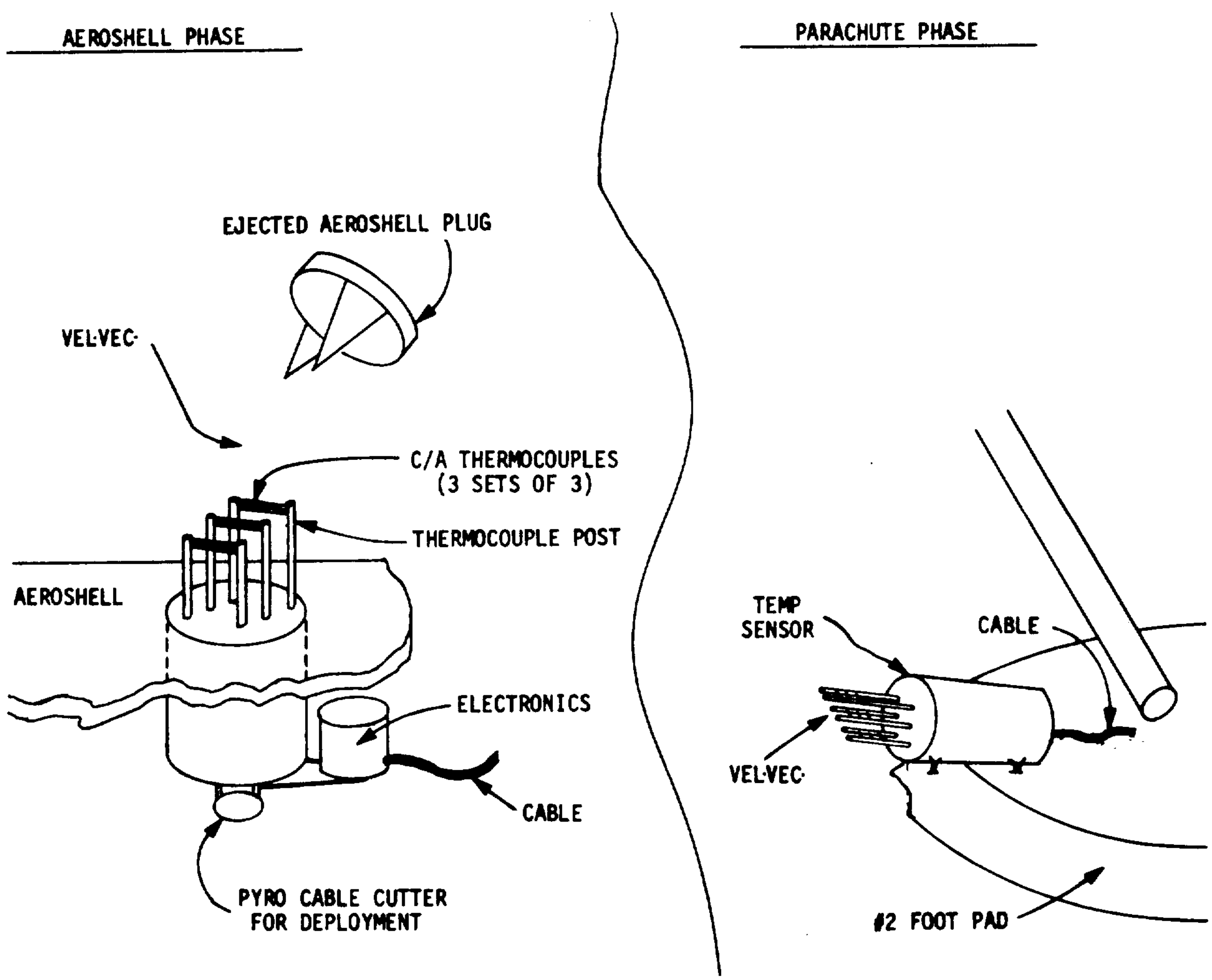
Dimensions: Aeroshell - approximately 508.1 cm^3 (31.0 $in.^3$)
Parachute - approximately 263.0 cm^3 (15.8 $in.^3$)

Weight: Aeroshell - 0.5 kg (1.1 lbs)
Parachute - 2.7 kg (0.6 lbs)

Power:	Aeroshell - less than 1.4 W Parachute - less than 1.4 W
Range:	Aeroshell - 100 to 750° K Parachute - 100 to 400° K

SOURCE:

Data:	Alvin Seiff, Ames Research Center. Viking Project Office, Langley Research Center, PD-7400086.
Reference:	Alvin Seiff, Ames Research Center. "Entry Science Experiments for Viking 1975," Icarus, Vol. 16, No. 1 (February, 1972), p. 85-90.



Viking A Entry Temperature Sensor

EXPERIMENT CATEGORY: Atmospheric Structure

DATE OF LAUNCH: August, 1975

INSTRUMENT NAME: Mars Atmospheric Water Vapor Detector (MAWD)

SPACECRAFT: Viking A (Orbiter)

DESTINATION: Planet Mars

PRINCIPAL INVESTIGATOR: C.B. Farmer, Jet Propulsion Laboratory

INSTRUMENT CONTRACTOR: Jet Propulsion Laboratory

PURPOSE: To aid in the selection/certification of landing sites for the Viking landers, to monitor the region surrounding the landers, and to provide additional spatial and temporal coverage in order to increase our knowledge of the planet and to aid in the selection of future landing sites. To determine the horizontal distribution of water vapor.

DESCRIPTION: The Mars atmospheric water vapor mapping investigation is conducted using an infrared spectrometer, which is boresighted with the bisector of the TV cameras. The instrument has a field of view of 24 x 45 km from an altitude of 1500 km. This field of view is provided by a raster (scanning) mirror with 15 discrete positions which have a field of view of 3 x 24 km each. The MAWD is a fixed grating monochromater of the Pfund-Littrow design using a five-element PbS detector operating in the 1.38 micron band. Radiation from the planet is focused onto the input slit of the monochromator by a small input lens, which views the planet surface via an external scanning (raster) mirror. The radiation is collimated by the 50 cm focal length paraboloid collimating mirror and then falls onto the 12,000 lines per cm grating. The dispersed energy is reimaged by the collimating mirror onto the detectors. The signals from the detectors are amplified, synchronously demodulated, and integrated. The wavelength setting of the monochromator is maintained throughout the mission via a monitoring/servo system. A monochromator reference source passes radiation through the optics during the calibration period. If wavelength misalignment occurs, an error signal is generated and drives the servo which repositions the grating. The response of each channel is calibrated by periodically causing the scan mirror to view the output of a calibration source. A set of tungsten lamps is used to provide intensity calibration. The detector output data are used to reconstruct the instument responsivity to a relative accuracy (channel to channel) of 1% and an absolute accuracy of 10%.

PARAMETER SUMMARY:

Dimensions: Optical Head - 71.1 x 20.3 x 27.9 cm (28.0 x 8.0 x 11.0 in.)
Electronics Subassembly - 35.6 x 16.8 x 15.2 cm (14.0 x 6.6 x 6.0 in.)

Weight: 17.7 kg (39.0 lbs)

Power: 15 W

Range:

Channel	Function	Wavenumber cm^{-1}
1	Water Line	7223.12
2	Continuum	7224.50
3	Water Line	7232.20
4	Continuum	7238.50
5	Water Line	7242.75

Field of View: 24 x 45 km from altitude of 1500 km

Raster Mirror: (Scanning)
15 discrete positions with field of view of 3 x 24 km each

Detector: Five-element PbS operating in 1.38 micron band

Focal Length: 50 cm

Relative Accuracy: 1%

Absolute Accuracy: 10%

Lamps: Tungsten (a set)

SOURCE:

Data: O.S. Childress - Orbiter, Science Instrument & Flight Data Mgr., Langley Research Center.

Reference: Viking Project Office, Langley Research Center.

EXPERIMENT CATEGORY: Atmospheric Structure

DATE OF LAUNCH: August, 1975

INSTRUMENT NAME: Retarding Potential Analyzer

SPACECRAFT: Viking A (Aeroshell)

DESTINATION: Planet Mars

PRINCIPAL INVESTIGATOR: W.H. Hanson, University of Texas - Dallas

INSTRUMENT CONTRACTOR: Bendix Aerospace Systems Division, Ann Arbor, Mich.

PURPOSE: To measure the ion and electron concentration and their energy distribution in the Martian ionosphere during entry.

DESCRIPTION: The instrument consists of a sensor head and associated electronics. The sensor head contains planar grids and collector. The collector is connected to an automatic range-changing linear electrometer which provides telemetry inputs.

PARAMETER SUMMARY:

Dimensions: 10.2 x 17.8 x 14.5 cm (4.0 x 7.0 x 5.7 in.)

Weight: 1.3 kg (2.8 lbs)

Power: 2.5 W

Ion Mode:
Sweep Time - 2 sec
Voltage Sweep - + 15 to 0
Current Range - 3×10^{-13} to 3×10^{-8} x amp (eff)
Bandwidth - 150 Hz

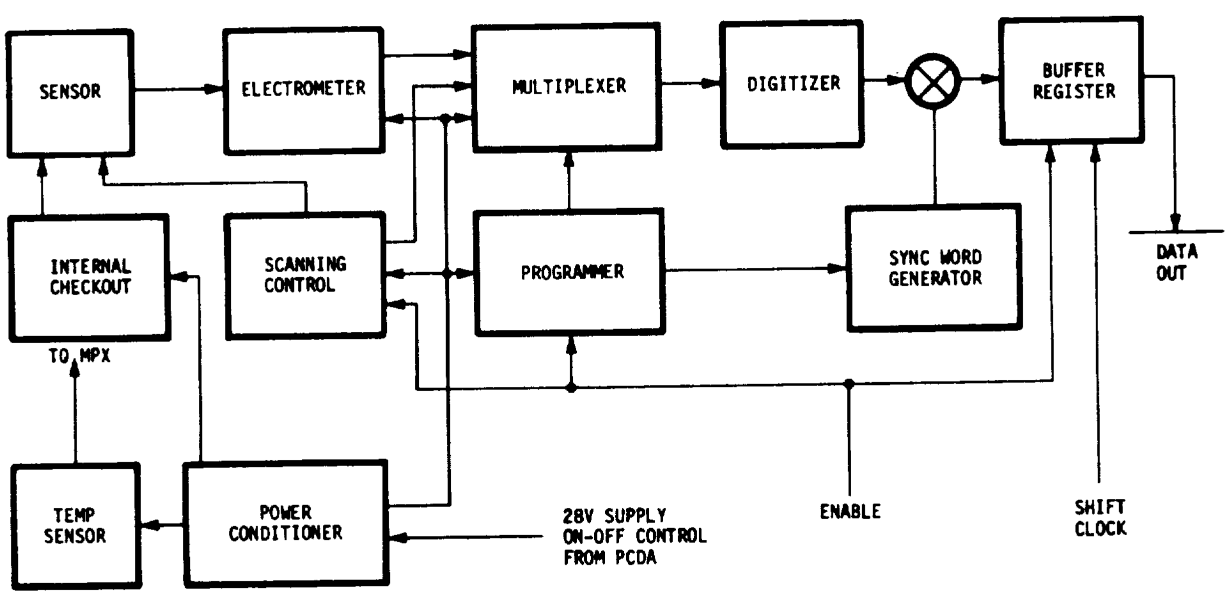
Energetic Electron Mode:
Sweep Time - 1 sec
Voltage Sweep - -75 to 0
Current Range - 3×10^{-13} to 2×10^{-19} amp (eff)
Bandwidth - 20 Hz

Thermal Electron Mode:
Sweep Time - 1 sec
Voltage Sweep - + 15 to 0
Current Range - 3×10^{-13} to 3×10^{-8} amp (eff)
Bandwidth - 150 Hz

SOURCE:

Data: Viking Project Office, Langley Research Center.

Reference: Same as above.



Viking A Retarding Potential Analyzer Block Diagram

EXPERIMENT CATEGORY:	Atmospheric Structure
DATE OF LAUNCH:	August, 1975
INSTRUMENT NAME:	Upper Atmosphere Mass Spectrometer (UAMS)
SPACECRAFT:	Viking A (Aeroshell)
DESTINATION:	Planet Mars
PRINCIPAL INVESTIGATOR:	A.O.C. Nier, University of Minnesota
INSTRUMENT CONTRACTOR:	Bendix Aerospace Systems Division, Ann Arbor, Michigan

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PURPOSE: To measure the neutral composition of the upper atmosphere of Mars during entry.

DESCRIPTION: The instrument is a semiautomatic internally programmed double-focusing magnetic sector mass spectrometer, employing the Mattauch-Herzog geometry. It detects and analyzes the neutral species in the upper atmosphere of Mars during entry. An ion pump forms a part of the experiment. The instrument is mounted in an opening at the center of the aeroshell, with the ion source recessed below the surface of the aeroshell. The spectrometer makes a minimum of six mass analyses at equal altitude intervals during the period from de-orbit to an altitude that corresponds to a pressure of 0.001 mb. While on the surface, four analyses are performed each day for the first three days at times suitable for the detection of diurnal variations. Other analyses are made every six days for the remainder of the ninety day lander lifetime. The major components of this instrument are: an ion source cover, ion source, electrostatic analyzer, magnetic analyzer, ion collector, electrometers, high voltage power supply, digital control logic, analog electronics, and digital data systems.

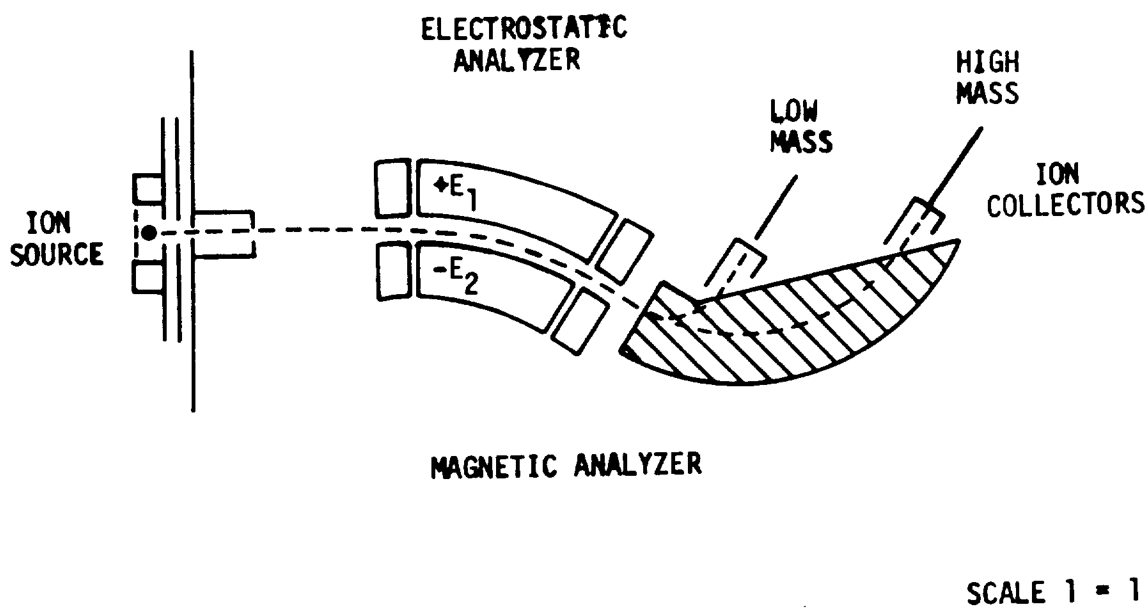
PARAMETER SUMMARY:

Dimensions:	30.5 x 22.9 x 30.5 cm (12.0 x 9.0 x 12.0 in.)
Weight:	4.8 kg (10.5 lbs)
Power:	9 W (average), 17 W (peak)

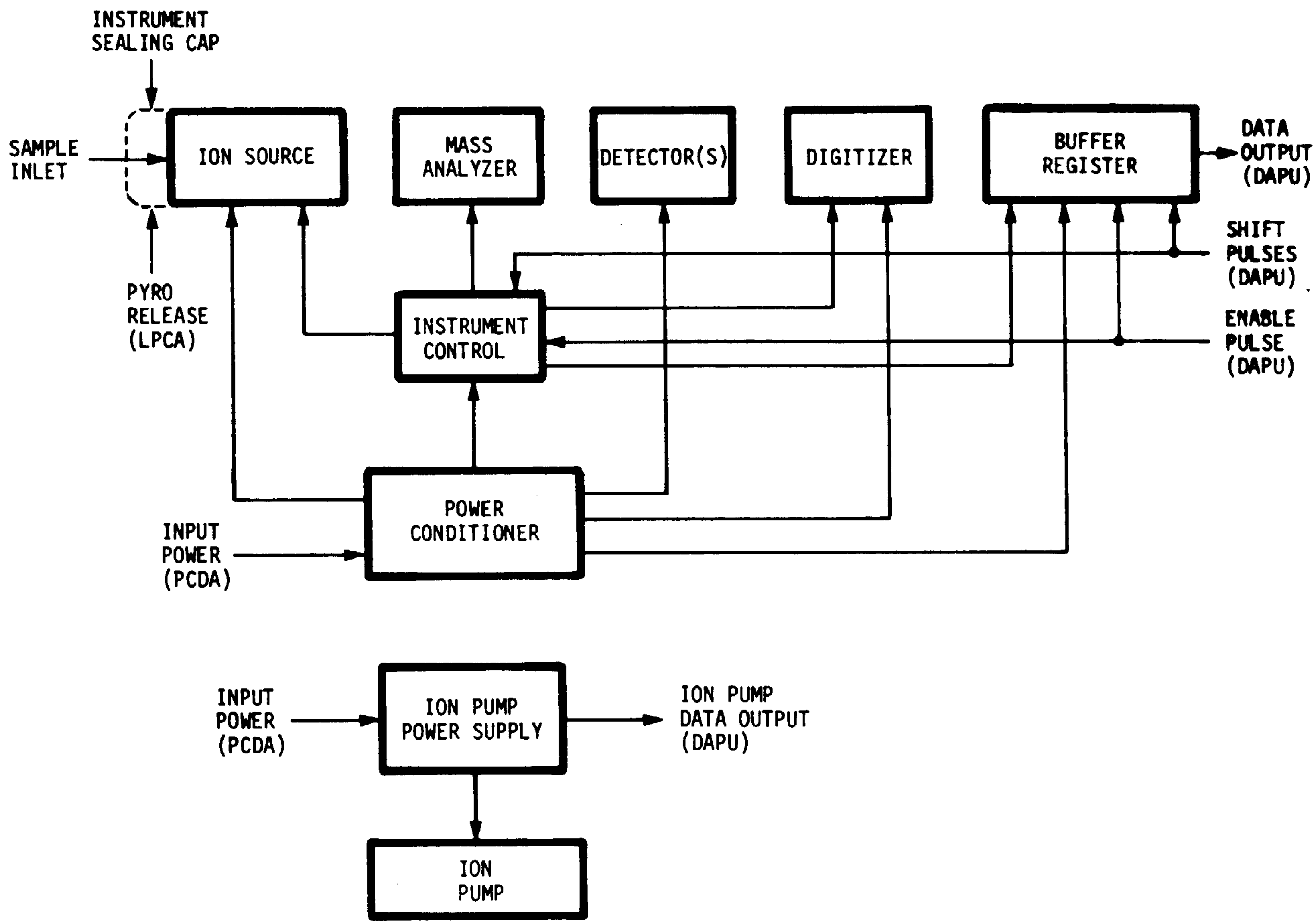
Mass Range:	1 - 50 AMU
Dynamic Range:	Overall - 10^6 Within a Scan - 10^5
Accuracy:	20%
Reproducible Ability:	3% Scan Time - 5 sec
Pressure Range:	10^{-10} to 10^{-4}
Resolution:	Interference 1/300, adj. peaks
Data Requirements:	800 bits/sec

SOURCE:

Data:	NSSDC AIM Printout (2 October, 1972), ID No. VIKNG-A-04. Viking Project Office, Langley Research Center.
Reference:	"Entry Science Experiments for Viking 1975," Icarus, Vol. 16, No. 1 (February, 1972), p. 80-83.



Viking A Upper Atmosphere Mass Spectrometer



Viking A Upper Atmosphere Mass Spectrometer Block Diagram

EXPERIMENT CATEGORY:	Atmospheric Structure
DATE OF LAUNCH:	August, 1975
INSTRUMENT NAME:	Viking Meteorology Instrument System
SPACECRAFT:	Viking A (Lander)
DESTINATION:	Planet Mars
PRINCIPAL INVESTIGATOR:	Seymour L. Hess, Florida State University
INSTRUMENT CONTRACTOR:	Martin Marietta Aerospace TRW, Subcontractor

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PURPOSE: To measure the atmospheric temperature, pressure, and wind velocity on the surface of the planet Mars.

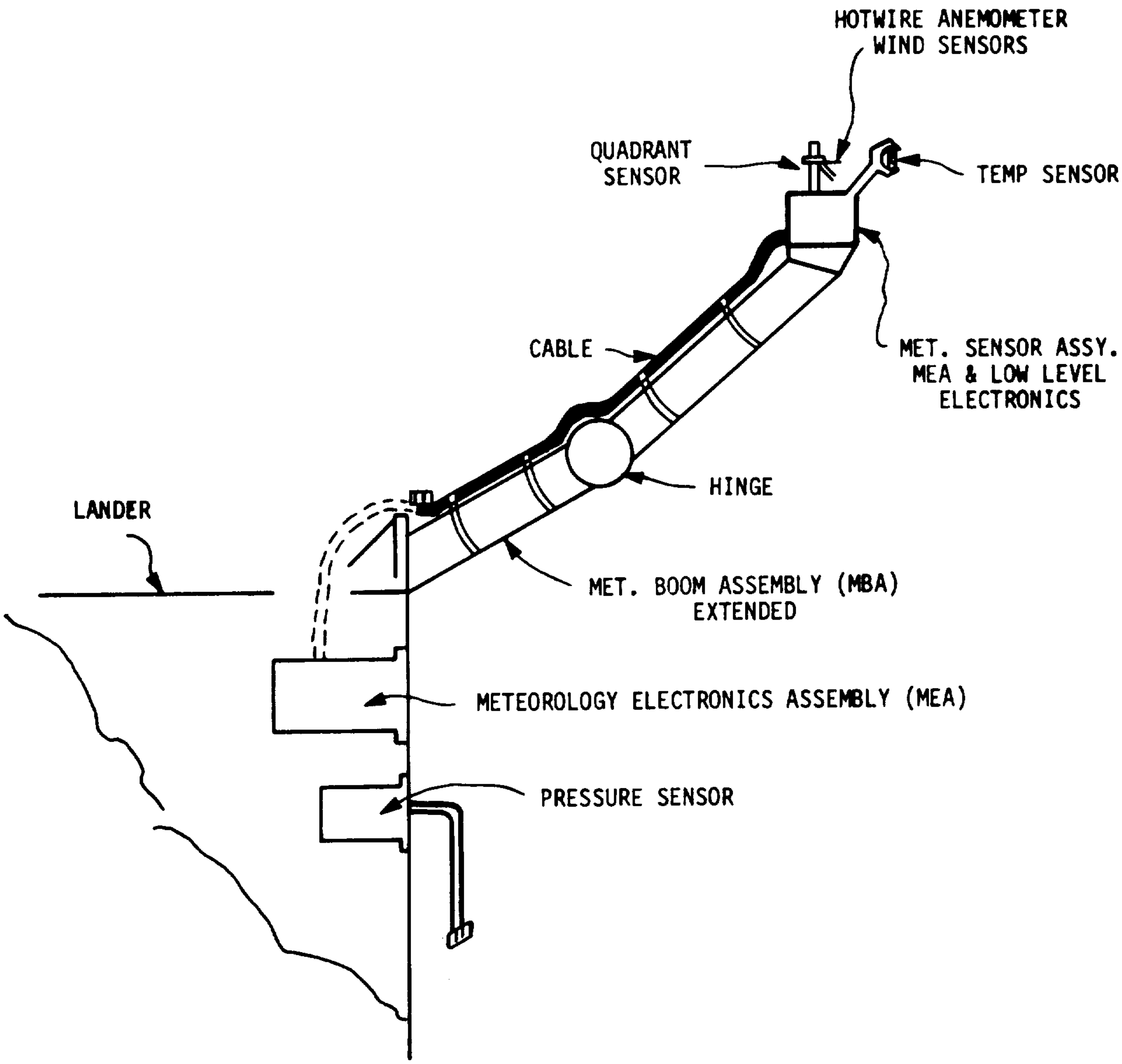
DESCRIPTION: For this instrument the sensors may be mounted on structures already available such as footpads, antenna masts, imagery masts, or the sampler arm. Diurnal and temporal variations of the parameter are of particular importance. Measurements are made at least every two minutes. Water vapor is measured at least every two hours. All measurements are continued for the lander lifetime.

PARAMETER SUMMARY:

Dimensions:	Approximately 12,456 cm^3 (760 $in.^3$)
Weight:	4.9 kg (10.7 lbs)
Power:	Operate - 13 W (peak), 6.6 W (average) Stand-By - 2 W (peak), 1 W (average)
Range:	Pressure - 0 - 30 mb Temperature - 130 - 350° K Wind Speed - 2 - 150 m/sec Wind Direction - 0 - 360°

SOURCE:

Data:	NSSDC AIM Printout (2 October 1972), ID No. VIKNG-A-10. Viking Project Office, Langley Research Center, PD-7400090.
Reference:	Viking Project Office, Langley Research Center.



Viking A Meteorology Instrument System

EXPERIMENT CATEGORY: Biological/Medical

DATE OF LAUNCH: August, 1975

INSTRUMENT NAME: Biology Investigation

SPACECRAFT: Viking A (Lander)

DESTINATION: Planet Mars

PRINCIPAL INVESTIGATOR: H.P. Klein, Ames Research Center

INSTRUMENT CONTRACTOR: Langley Research Center
Martin Marietta Aerospace
TRW, Incorporated

PURPOSE: To indicate life on Mars by performing biological tests for growth, metabolism and photosynthesis.

DESCRIPTION: The biology investigation consists of three experiments performed upon portions of a common sample collected from the Martian surface. The three experimetns are: Photosynthetic and respiratory fixation of carbon dioxide and/or carbon monoxide (pyrolytic release), metabolic release from labelled substrates (labelled release), and gas composition changes (gas exchange).

PARAMETER SUMMARY:

Dimensions:

Weight: 18.1 kg (39.8 lbs)

Power:

Range:

SOURCE:

Data: Viking Project Office, Langley Research Center

Reference: Same as above.

EXPERIMENT CATEGORY:	Infrared Radiometry
DATE OF LAUNCH:	August, 1975
INSTRUMENT NAME:	Infrared Thermal Mapper (IRTM)
SPACECRAFT:	Viking A (Orbiter)
DESTINATION:	Planet Mars
PRINCIPAL INVESTIGATOR:	H.H. Kieffer, U.C.L.A.
INSTRUMENT CONTRACTOR:	Jet Propulsion Laboratory Santa Barbara Research Center

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PURPOSE: To obtain surface temperature data of Mars to aid in the selection/certification of landing sites for the Viking landers, to monitor the region surrounding the landers, and to provide additional spatial and temporal coverage in order to increase our knowledge of the planet and to aid in the selection of future landing sites.

DESCRIPTION: The instrument uses a multichannel infrared radiometer. The instrument has a crosstrack area of coverage of approximately 57.6 km. The design concept is similar to that employed in the Mariner missions. The basic differences are in the optical system, spectral bands and range, and detector design. Spatial coverage is obtained by the travel of the Orbiter. Spectral coverage is provided by an array of selected detectors associated with telescopes to cover spectral bands from 0.3 to 24.0 microns. The instantaneous field of view of each channel (detector) is 0.3° for a seven detector arrangement in a chevron array. The instrument has an optical system consisting of a 45° scan mirror, three 5.1-cm (2.0-in.) diameter, f/2.5 Cassegrain reflecting telescopes, and associated detector assemblies. In addition, there is a 2.5-cm (1.0-in.) diameter, f/5 telescope with refractive optics and a detector assembly to cover the 0.24 to 3.0 micron band. The four telescopes are boresighted so that the individual field of view coincide in object space to produce a single chevron array pattern in object space. The object space array is boresighted with the bisector of the TV cameras. The 45° scan mirror has three discrete positions: planet, space view, and an internal reference (temp.) surface. The detector arrays are composed of 28 (7 each array) identical antimony-bismuth thermopile detectors. Calibration is provided for the four long wavelength channels by the internal reference surface and the short wavelength channel using an incandescent reference lamp. The other required calibration point is provided by pointing the mirror to deep space.

PARAMETER SUMMARY:

Dimensions: 41.9 x 34.3 x 18.3 cm (16.5 x 13.5 x 7.2 in.)

Weight: 9.5 kg (21.0 lbs)

Power: 15 W (peak)

Range:

Telescope	Spectral Range - Microns
A	18.2 to 24.0
B	9.8 to 12.7
C1	6.1 to 8.35
C2	8.35 to 9.8
C3	15
D	0.24 to 3.0

Mirror: 45° scan

IFOV: 0.3°

Telescopes: Cassegrain Reflecting - three, 5.1 cm (2.0 in.) diameter, f/2.5, boresighted
Refractive Optics - one, 2.54 cm (1.0 in.) diameter, f/5, boresighted

Detectors: 28 identical antimony-bismuth thermopile

Crosstrack Area of Coverage: Approximately 57.6 km

SOURCE:

Data: O.S. Childress - Orbiter, Science Inst. and Flight Data Mgr., Langley Research Center.

Reference: Viking Project Office, Langley Research Center.

EXPERIMENT CATEGORY: Seismic

DATE OF LAUNCH: August, 1975

INSTRUMENT NAME: Viking Seismometer

SPACECRAFT: Viking A (Lander)

DESTINATION: Planet Mars

PRINCIPAL INVESTIGATOR: D.L. Anderson, California Institute of Technology

INSTRUMENT CONTRACTOR: Bendix Aerospace Systems Division, Ann Arbor, Michigan

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PURPOSE: To provide information about the microseismic level and an upper bound on the seismicity of the planet Mars.

DESCRIPTION: This instrument consists of a triaxial ground motion sensor assembly and associated electronics. Included are three velocity sensors, amplification, filtering, triggering, and data compaction within the frequency range of 0.1 to 4 Hz with a ground displacement resolution of 50×10^{-6} millimeters at 1 Hz. A power converter and data handling subsystem are provided. The instrument is mounted in the science equipment section of the Viking Lander Spacecraft to a lander leg.

PARAMETER SUMMARY:

Dimensions: 16.5 x 12.7 x 12.4 cm (6.5 x 5.0 x 4.9 in.)

Weight: 1.8 kg (4.0 lbs)

Power: 2.6 W

Range: At the highest gain setting the unit detects ground displacement in all three axes, of 50×10^{-6} millimeters, 0 to peak, or less, at a frequency of 1.0 ± 0.1 Hz and 1×10^{-6} millimeters or less, at 4.0 ± 1 Hz with a signal-to-noise ratio of 1 or greater. The response of the unit is monotonic between 0.5 and 4 Hz. The total range of the experiment is 76 dB (40 dB at each gain setting plus 36 dB commandable gain variation).

SOURCE:

Data:	Project Documentation - PD7400072, Mission Def., Icarus, Bx Proposal BSD 1496.
Reference:	Viking Project Office, Langley Research Center.

EXPERIMENT CATEGORY: Surface Composition

DATE OF LAUNCH: August, 1975

INSTRUMENT NAME: Gas Chromatograph - Mass Spectrometer

SPACECRAFT: Viking A (Lander)

DESTINATION: Planet Mars

PRINCIPAL INVESTIGATOR: Klaus Biemann, Massachusetts Institute of Technology

INSTRUMENT CONTRACTOR: Litton Systems, Inc.

PURPOSE: To analyze the surface of Mars for organic content, to identify the constituents of the Martian atmosphere and their relative abundance both without removal of CO/CO_2 and with CO/CO_2 removed, and to estimate the water content in the Mars surface material.

DESCRIPTION: This instrument consists of the following major components:

I. Sensor Tray

1. Hydrogen Supply System
2. Surface Sample Loader & Processor Assembly
   (a) Oven carriage mechanism
   (b) Oven Loader
   (c) Pyrolysis Ovens
   (d) Oven Sealing Mechanism
3. GC Column - Dexcil 300 & HiEF 8 on Chromosorb WHP
4. Hydrogen Separator & Effluent Divider - Hi Conductuance, High Temperature, Low Dead Volume Valves
5. Mass Spectrometer - Double Focusing (Nier-Johnson)
6. Mass Spectrometer Electronics - Electrometers, A-D Converter
7. Atmospheric Inlet & Filters Assembly

II. Electronics Tray

1. Heater Controllers
2. Valve Drivers
3. Power Supplies

III. Instrument Data System Tray

1. Command Decoder & Sequencer
2. Data Handling System

PARAMETER SUMMARY:

Dimensions: 27.3 x 25.4 x 36.2 cm (10.7 x 10.0 x 14.2 in.)

Weight: 18.6 kg (41.0 lbs)

Power:

Power Requirements	Initial	Final
Organic Analysis	60 W/90 Min.	72 W/124 Min.
Atmospheric Analysis	18 W/61 Min.	
Iou Pump (Idling)	2 W	1 W

Range: 12 to 200 AMU

Number of Organic Samples: 3

Number of Effluent Divider: 4

Column High Temperature Hold: 200° C

GC Peak Width: 20 to 40 sec

Smallest Detectable GC Peak: 10 nanograms

SOURCE:

Data: Viking Project Office, Langley Research Center

Reference: Same as above.

EXPERIMENT CATEGORY:	Visible Frequency, Cameras
DATE OF LAUNCH:	August, 1975
INSTRUMENT NAME:	Visual Imaging Subsystem (VIS)
SPACECRAFT:	Viking A (Orbiter)
DESTINATION:	Planet Mars
PRINCIPAL INVESTIGATOR:	M. Carr, U.S. Geological Survey, Menlo Park, Calif.
INSTRUMENT CONTRACTOR:	Jet Propulsion Laboratory Ball Brothers Research Corporation

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PURPOSE: To aid in the selection/certification of landing sites for the Viking landers, to monitor the region surrounding the landers, and to provide additional spatial and temporal coverage in order to increase our knowledge of the planet and to aid in the selection of future landing sites.

DESCRIPTION: The imaging investigation uses two identical cameras. Each camera consists of the optics, sensor, shutter, and supporting electronics. The cameras are mounted on a two-degree-of-freedom (scan) platform attached to the Orbiter. The cameras are mounted so that the central scan line, of each camera, is parallel to the mounting plate. The combined cross track field-of-view of both cameras gives a swath width of approximately 80 km from an orbital altitude of 1500 km. The camera sensor is a 3.8 cm (1.5 in.) vidicon with response in the 360 to 650 nanometer range. Exposure control is provided by a mechanical shutter with 22 settings from 0 to 2.66 sec in geometric progression. Each optical system consists of a 475 mm focal length all spherical catadioptric cassegrain telescope and a filter wheel. Imaging data is acquired by alternately exposing and reading out the two cameras to provide a continuous data stream. Intensity data are converted to digital form with an encoding accuracy of one part in 256. The digital data are then stored on a magnetic tape recorder for subsequent playback at a rate consistent with the Orbiter-to-Earth communications link. The design of the Orbiter Imaging Subsystem is based on obtaining pictures with a resolution of approximately 40 meters per TV line. This system is a further development of the Mariner high resolution camera to meet the Viking requirements.

PARAMETER SUMMARY:

Dimensions:	Camera Heads - 22.9 cm (9.0 in.) diameter, 83.8 cm (33.0 in.) long Two Chassis (Each) - 17.8 x 16.8 x 3.8 cm (7.0 x 6.6 x 1.5 in.)
Weight:	42.1 kg (92.7 lbs)
Power:	45 W
Range:	Spectral - 360 to 650 nanometers
Filters:	Clear, Red, Minus Blue, Green, Blue, Violet
FOV:	Single camera - 31.16 x 27.84 mrad
Focal Length:	475 mm
Resolution:	Approximately 40 meters per TV line
Camera Sensor:	3.8 cm (1.5 in.) vidicon
Swath Width:	Approximately 80 km from orbital altitude of 1500 km
Mechanical Shutter:	22 settings from 0 to 2.66 sec in geometric progression

SOURCE:

Data:	O.S. Childress - Orbiter, Science Institute and Flight Data Manager, Langley Research Center.
Reference:	"Imaging Experiment - The Viking Mars Orbiter," Icarus, Vol. 16, No. 1 (February, 1972), p. 17-24. Viking Project Office, Langley Research Center.

EXPERIMENT CATEGORY:	X-Ray
DATE OF LAUNCH:	August, 1975
INSTRUMENT NAME:	X-Ray Fluorescence Spectrometer
SPACECRAFT:	Viking A (Lander)
DESTINATION:	Planet Mars
PRINCIPAL INVESTIGATOR:	Priestley Toulmin III, United States Geological Survey
INSTRUMENT CONTRACTOR:	Martin Marietta Aerospace

PURPOSE: To obtain an elemental analysis of Martian surface material and an estimate of mineralogy and density of surface material.

DESCRIPTION: Using radioactive isotopes as an excitation source, the fluorescence X-rays given off by a sample of surface material are detected by proportional counters. The energy dispersion of the X-ray is obtained using electronic discrimination and compared to standards for determining elemental analysis. The major components of this experiment are as follows: Two radioactive sources, four proportional counters, high voltage power supply, charge sensitive preamplifier/shaping amplifier, pulse height discriminator, logic control and command register, data multiplexer and memory sample inlet assembly and sample dump mechanism, and calibration plaques and sample analysis windows.

PARAMETER SUMMARY:

Dimensions:	22.9 x 15.2 x 7.6 cm (9.0 x 6.0 x 3.0 in.)
Weight:	2.0 kg (4.5 lbs)
Power:	5 W (average), 35 W (Peak, Solenoid Operation)
Range:	0.6 Ker to 30 Ker
Accuracy:	.02% to 2% depending on element of interest and matrix interactions

Range:	Detects individual elements having atomic numbers 12 and above
Number of Samples:	Minimum of 6
Sample Size:	30 cc each
Particle Size:	300 μ to 12,000 μ
Data Cycle:	5 hours for analysis and 5 hours for calibration
Word Length:	320 bits
Total Number of Bits:	(Analysis & Calibration Cycle) 20,000 Bits

SOURCE:

Data:	Viking Project Office, Langley Research Center.
Reference:	Same as above.

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X-RAY